University of Cambridge Institute for Sustainability Leadership

Corporate Leaders Group UK

Powering prosperity

How electrification can strengthen the UK's economy, resilience and energy security

Policy Briefing
June 2026

We Mean Business Coalition

The University of Cambridge Institute for Sustainability Leadership (CISL)

CISL is an impact-led institute within the University of Cambridge developing industry leadership, sector pathways and commercially-viable solutions to transform markets for a sustainable future.

For over three decades we have worked with leaders and innovators across business, finance and government to accelerate action.

We believe wide-scale change can happen through markets and take an evidence-based approach to transition pathways which inform strategy, action and investment to enable an inclusive and resilient economy.

Through our hubs in Cambridge, Cape Town and Brussels, and a global network of leaders and partners, we bring together insight, influence and action to accelerate marketwide transformation.

Corporate Leaders Group UK

The Corporate Leaders Group UK (CLG UK) is a cross-sector business group activating leadership and innovation to transform the UK economy.

Established in 2005, CLG UK represents businesses leading the transition to unlock a cleaner, competitive and resilient Britain. By providing members with insight, influence and opportunities for impact, CLG UK is creating a movement of businesses shaping the markets of the future. No single business can do it alone, but a movement of businesses can make this change unstoppable.

CLG UK is convened by the University of Cambridge Institute for Sustainability Leadership. It is guided by CISL's world-class expertise and specialist teams to build understanding and shape policy for a sustainable economy.

We Mean Business Coalition

We Mean Business Coalition works with the world's most influential businesses to take action on climate change. The Coalition is a group of seven nonprofit organisations: BSR, CDP, Ceres, Climate Group, CLG Europe, CLG UK, The B Team and WBCSD. Together, they catalyse business and policy action to halve emissions by 2030 and accelerate an inclusive transition to a net-zero economy.

Disclaimer

The views expressed here are those of the authors and do not represent an official position of CISL, the University of Cambridge, or any of its individual business partners or clients.

Citing this report

University of Cambridge Institute for Sustainability Leadership (CISL). (2026). *Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security*. Cambridge, UK: Cambridge Institute for Sustainability Leadership.

Authors

Dr Sanna Markkanen, Anum Yousaf Sheikh

Acknowledgements

We are grateful to the following, whose insights and feedback have greatly supported the work:

CISL contributors: Bev Cornaby, Eliot Whittington, Isabelle Cross, Viola Meyerweissflog, Wilson Delaney

Our Corporate Leaders Group UK members

Cambridge Econometrics

We Mean Business Coalition

Furthermore, we thank our CISL colleagues for their collaboration on this publication.

This work was funded by We Mean Business Coalition as part of the Electric Advantage programme. Electric Advantage is a multi-year program focused on spurring industry action, reforming regulations and driving investment in electrification to accelerate us all toward a cheaper, safer, healthier future. It is a collaborative effort between BSR, Ceres, Climate Group, CLG UK & Europe, The B Team and WBCSD.

Contents

Executive summary	**4**
1. Introduction	**6**
2. The strategic advantage of electricity	**8**
2.1 Superior efficiency	8
2.2 Domestic, scalable and secure source of energy	9
2.3 Lower emissions	12
2.4 Implications for the UK energy system	12
3. Modelling scenarios and methodology	**14**
3.1 Short description of the E3ME model	14
3.2 The modelling approach	14
3.3 Scenarios	14
4. Economic impacts	**17**
5. Employment impacts	**19**
6. Energy security and resilience	**20**
7. Environmental outcomes	**22**
8. Energy expenditure	**24**
9. Unlocking electrification: barriers and priority actions	**26**
9.1 Electricity pricing	26
9.2 Capital investment need	28
9.3 Planning, investment signals and system readiness	29
9.4 Access to finance and insurance	31
9.5 Awareness, trust and skills	32
9.6 Additional constraints affecting industrial operations	33
10. Conclusions	**34**
References	**35**

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

Executive summary

The UK is entering a period of heightened geopolitical and economic uncertainty, marked by volatile global energy markets, supply chain disruptions and increasing pressure to strengthen domestic resilience. Recent shocks – including sharp increases in fossil fuel prices – have exposed the risks of continued reliance on imported fuels. In this context, electrification – ie replacing fossil fuels with electricity for uses such as heat, transport and industry – offers a strategic pathway to enhance economic performance, energy security and long-term competitiveness.

Electrification creates a foundation for a more resilient, stable and competitive UK economy, providing structural advantages that extend well beyond decarbonisation. Electrified technologies are typically more energy efficient than fossil fuel alternatives, reducing overall energy demand and improving productivity. Electricity can also be generated domestically from diverse and increasingly low-cost sources, including renewables and nuclear. Together, these characteristics create a foundation for a more resilient, stable and competitive UK economy.

This report compares three alternative development pathways for the UK against a current policies baseline using macroeconomic modelling by Cambridge Econometrics:

- an electrification-led pathway
- a mixed technologies pathway
- a fossil fuel-led alternative

The electrification-led pathway delivers the best economic and energy security outcomes, with benefits increasing with the degree of electrification. This scenario achieves the highest gross domestic product (GDP) growth, supported by early and sustained investment in domestic infrastructure and low carbon technologies. These investments generate multiplier effects across the economy, driving innovation, increasing productivity and supporting job creation in high-value sectors. By contrast, the fossil fuel-led pathway delivers only short-term gains, with economic performance weakening over time as domestic resources decline and exposure to global markets persists.

Electrification supports job creation across a broad range of sectors, including energy infrastructure, manufacturing and services, reflecting the more labour-intensive nature of domestic clean electricity systems compared to fossil fuel extraction. In contrast, fossil fuel-led growth delivers fewer and less sustained employment benefits.

Electrification also plays a critical role in strengthening energy security and economic resilience. By reducing dependence on imported oil and gas, electrified pathways significantly lower the UK's exposure to global price shocks. The modelling suggests that fossil fuel imports could fall by around 50–60 per cent relative to current trajectories under electrification-led scenarios. This translates into lower and more stable energy costs for households and businesses, reduced inflationary pressures and a more predictable environment for investment. These benefits are particularly pronounced under scenarios of high fossil fuel prices, where electrification reduces vulnerability to external shocks.

Environmental improvements are substantial under electrification-led and mixed technologies pathways, with electrification enabling deep emissions reductions across transport, heating and industry. However, a key insight of this report is that emissions reduction is not the only – or even the primary – driver of value. The economic and resilience benefits of electrification are equally significant, and in some cases more immediate.

Despite these advantages, electrification in the UK remains limited. Electricity accounts for less than a quarter of the country's final energy consumption, with fossil fuel consumption continuing to dominate in key sectors – including ones that could be electrified using currently available technologies. This is due to a set of persistent and interrelated barriers.

1. Electricity pricing structures discourage electrification. Policy costs are loaded on to electricity bills to a greater extent than gas bills, and elements of the electricity market design mean that the lower generation cost of renewables is not reflected in electricity prices. This undermines the cost advantage of efficient electric technologies, particularly when compared to alternatives that use gas, and slows adoption.

2. Electrified technologies often require significant upfront investment, alongside complementary upgrades needed to make homes, buildings and industrial sites suitable for electrification. This can include insulation, electrical rewiring, connection upgrades and removal of legacy gas systems, creating additional cost barriers.

3. Accelerating electrification will require substantial investment in electricity networks, storage and system flexibility to connect new generation capacity and meet rising demand. Grid reinforcement and expansion involve high costs, long delivery timelines and co-ordination challenges.

4. Access to finance and risk perception constrain deployment of electrified technologies. Less mature technologies may face higher costs of capital or limited insurance availability, particularly in capital-intensive sectors.

5. Limited awareness, skills and trusted information continue to slow uptake. Uncertainty around costs and performance – combined with skills shortages across supply chains – reduces confidence and delays investment decisions. Policy uncertainty exacerbates these challenges.

6. Specific constraints affect industrial users. These include the availability of non-energy inputs, the need for stable energy supply and exposure to international competition. These factors can limit the feasibility of electrification even where technologies are available.

Unlocking the full benefits of electrification will require co-ordinated action across business and government. Priority actions include:

- reforming energy pricing to reduce system costs and enable consumers to benefit from low-cost renewable electricity, strengthening the incentives to fuel switching
- reducing upfront costs through targeted financial support, innovative financing models and risk-sharing mechanisms
- accelerating infrastructure investment through improved planning, stronger demand signals and enhanced system co-ordination
- expanding access to finance and reducing risk through public guarantees, standardisation and clearer investment frameworks
- building workforce capability and improving information to support confident adoption of electrified technologies across households and businesses
- supporting industrial transition through targeted policy measures that address competitiveness, supply chain constraints and system integration challenges.

Taken together, the evidence presented in this report suggests that **electrification is not only essential for meeting climate targets – it is a strategic economic choice**. A faster and more co-ordinated transition to electrification can deliver stronger growth, greater resilience and improved energy security for the UK.

1. Introduction

This report examines the case for accelerating electrification in the UK, with a particular focus on its economic and strategic value. It explores the advantages of electrified technologies, assesses the potential benefits for households, businesses and the wider economy, and identifies the key barriers that must be addressed to unlock these benefits.

The UK is operating in an increasingly uncertain global environment, shaped by geopolitical instability, volatile energy prices, technological transformation and growing pressure to strengthen long-term economic resilience. Recent global events have exposed the risks associated with reliance on imported fossil fuels, highlighting the importance of building a more secure and stable energy system utilising domestically available resources.

Electrification – ie replacing fossil fuels with electricity for uses such as heat, transport and industry – is emerging as a critical pathway for reducing fossil fuel dependency and exposure to external shocks, while also supporting sustainable economic growth and the UK's climate commitments. Without widespread electrification across the economy, the UK will be unable to fully capture the economic and energy security benefits of its increasingly low carbon, domestically generated power system.

Electrification offers several structural advantages. Electric technologies are typically more energy efficient than fossil fuel-consuming alternatives. Electricity can also be generated from a diverse range of domestic sources, including renewables and nuclear. This creates an opportunity to reduce dependence on finite and internationally traded fuels, while improving the overall productivity of energy use across the economy.

Beyond system efficiency, electrification has the potential to deliver significant economic benefits. It can support innovation, unlock new investment opportunities, and drive job creation in emerging and established industries. At the same time, a more electrified energy system can enhance the UK's resilience to global supply disruptions and price volatility, helping to stabilise and lower costs for households and businesses. While the decarbonisation benefits of electrification are well established, its role in strengthening energy security and economic competitiveness is equally important and increasingly urgent.

However, these benefits have not yet been fully realised. Electricity currently accounts for less than a quarter of the UK's final energy demand, with fossil fuels continuing to dominate in key sectors. A range of structural, market and behavioural barriers continue to slow the pace of electrification, limiting its contribution to economic resilience and energy security.

The UK's policy and regulatory frameworks provide an important backdrop to the analysis presented in this report. Alongside its legally binding commitment to reach net zero emissions by 2050 and an ambitious Nationally Determined Contribution (NDC) targeting an 81 per cent reduction in greenhouse gas emissions by 2035 (from 1990 levels), there is a clear and growing focus on the role of electrification and clean power in supporting economic resilience, competitiveness and energy security.

Recent policy initiatives reinforce this direction. The Clean Power 2030 Action Plan prioritises accelerating renewable deployment, reforming electricity markets and mobilising investment, while the 2025 Modern Industrial Strategy and Clean Energy Industries Sector Plan highlight the role of electrification in strengthening industrial competitiveness and supporting the growth of domestic supply chains. Together, these policies reflect an increasingly integrated approach, where climate objectives are aligned with economic and energy security priorities.

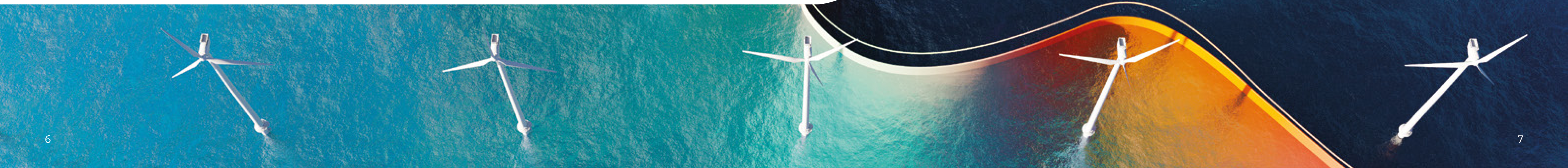
At the same time, the political and policy landscape in the UK is becoming more contested, with increasing emphasis on cost-effectiveness, delivery and energy security, and growing divergence in views on the pace and importance of the low carbon transition. In this context, exploring a range of plausible pathways – including those that prioritise electrification, adopt a more technology-neutral approach or diverge from current climate commitments – helps illustrate how different policy choices could shape the UK's long-term economic resilience, energy security and environmental performance.

The analysis presented in this report is informed by macroeconomic modelling commissioned from Cambridge Econometrics. The modelling compares three distinct scenarios for the future development of the UK energy system against a business-as-usual (BAU) baseline: an electrification-led pathway, a mixed technologies pathway and a fossil-led pathway.

This modelling enables a forward-looking assessment of how different pathways may impact energy costs, system resilience and economic outcomes. These insights are complemented by a broader evidence review and stakeholder-informed analysis.

This report is intended to support the development of practical, targeted actions by businesses and policymakers to accelerate electrification in the UK while also supporting the delivery of the targets outlined in Carbon Budget 7.[1] By bringing together quantitative modelling and qualitative insights, the report provides a robust, evidence-based foundation for decision-making among policymakers and business leaders.

The report is structured as follows. Chapter 2 sets out the strategic advantages of electricity, highlighting its efficiency, availability of domestic supply, emissions profile and implications for the UK energy system. Chapter 3 describes the modelling framework and scenarios used to assess the three different development pathways. Chapters 4 to 8 present the results of the modelling exercise, examining the economic, employment, energy security, environmental and expenditure impacts under each scenario. Chapter 9 identifies the key barriers to electrification in the UK and outlines priority actions for businesses and policymakers to address them. The report concludes in Chapter 10 by drawing together the main findings and implications for the UK's future strategy for economic development and energy security.



2. The strategic advantage of electricity

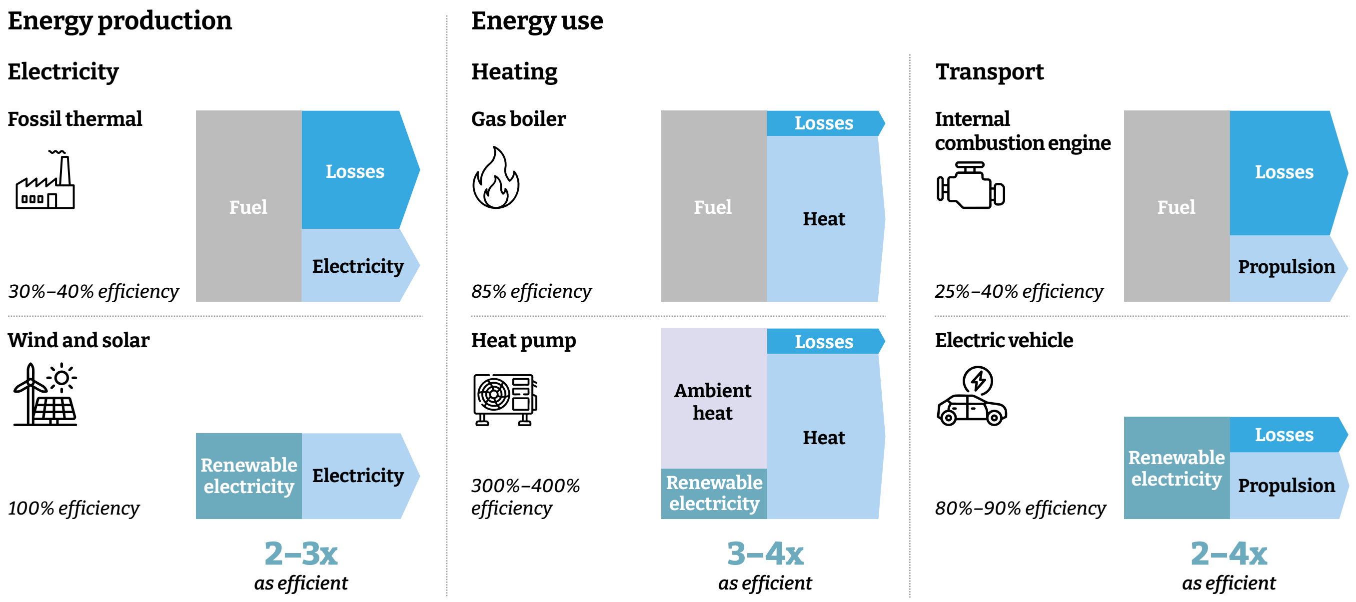
Electricity has many good qualities compared to fossil fuels. These include superior efficiency, secure and scalable domestic supply, and low greenhouse gas (GHG) emissions. However, the system-wide benefits that electrification could deliver remain limited because of the UK's heavy reliance on fossil fuels, including in sectors and uses that could be electrified.

2.1 Superior efficiency

Electricity delivers more useful energy per unit of input, reducing overall system demand and costs. It converts nearly 100 per cent of energy into heat or power at the point of use. When electricity is generated from renewable sources, unlike gas, it incurs no combustion losses (eg flue gases, heat loss).

Some electric technologies, such as heat pumps (domestic, industrial and those used for district heating) can achieve efficiencies over 300 per cent or more by moving heat rather than creating it. This high efficiency means that electrified systems require substantially less energy to deliver the same.[2] Superior efficiencies compared to fossil fuel technologies mean that electric technologies can deliver the same output with lower generation capacity. Figure 1 illustrates this efficiency advantage for electrified technologies vs fossil fuel-powered ones.

Figure 1: Efficiency of electric technologies vs fossil-fuelled equivalents



Source: RMI, The Cleantech Revolution, 2024, p43

Many electric technologies are also cheaper to maintain than their gas-fuelled alternatives. For example, a medium sized battery electric vehicle (BEV) typically has a lower total cost of ownership than a comparable internal combustion engine (ICE) vehicle. Even where BEVs still involve higher upfront costs – a pattern that is becoming less common in the UK[3] – these are outweighed over time by lower running costs, including fuel, maintenance and vehicle excise duty.[4] This advantage is amplified during periods of rapidly rising petrol prices, which are more volatile and vulnerable to global oil market shocks than electricity prices.

However, lower operating costs do not apply to all uses. For example, many electrified industrial applications are currently significantly more costly to install and operate than fossil fuel-consuming incumbent technologies.[5]

2.2 Domestic, scalable and secure source of energy

The UK has become increasingly dependent on imported fossil fuels over the past two decades (Figure 2). This exposes households and businesses to global price volatility and supply disruptions driven by geopolitical events and international energy markets. Because oil and gas are traded globally, domestic consumers remain vulnerable to price shocks largely beyond the UK's control.

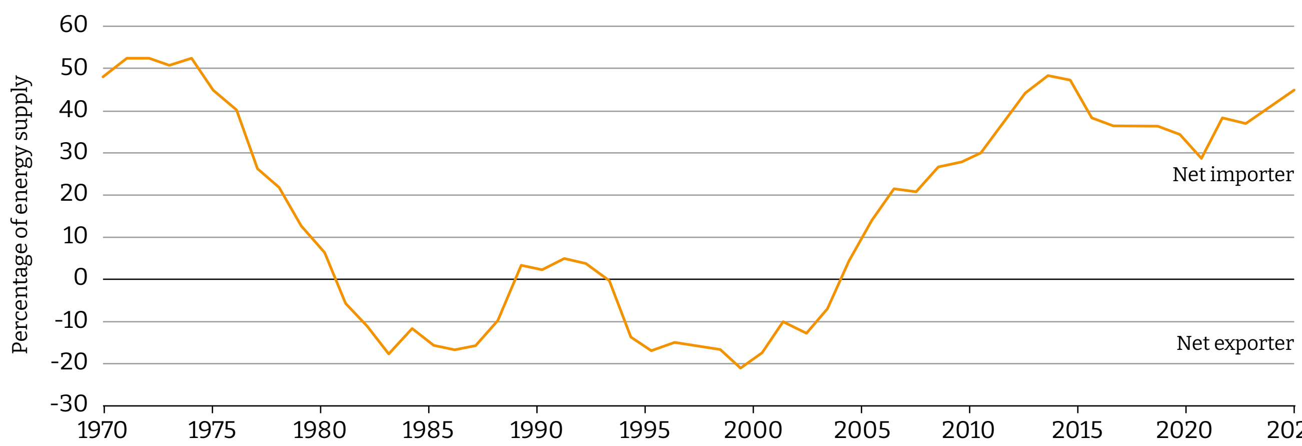
Electricity generated from domestic low carbon sources offers a more secure and stable alternative to fossil fuels. Renewable electricity can be produced from domestic resources such as wind and solar, reducing reliance on imported fuels and improving energy resilience. As the share of domestically generated electricity increases, the UK gains greater control over its energy supply and price stability.

Renewable electricity differs fundamentally from fossil fuel generation in how costs arise. Fossil fuel generation depends on continuous fuel purchases, leaving prices exposed to international market fluctuations. Renewables, on the other hand, rely mainly on upfront investment. Once infrastructure such as wind farms or solar installations is built, operating costs are relatively low and stable because there is no ongoing fuel requirement.

Although some equipment and materials – such as solar photovoltaics (PVs), wind turbine components and critical minerals – need to be imported, these dependencies are less economically risky than continued reliance on imported fuels. Future innovation in recycling, material efficiency and alternative technologies may also reduce these dependencies over time.

The economics of renewable electricity have improved significantly over the past two decades. The cost of technologies such as solar PV and onshore wind has fallen rapidly due to technological innovation, economies of scale and more competitive supply chains.[6]

Figure 2: UK fossil fuel import dependency (1970–2024)



Source: DESNZ, UK Energy in Brief 2025, 2025, p. 11

Globally, 91 per cent of new renewable power projects commissioned in 2024 produced electricity at a lower cost than fossil fuel-fired alternatives, even when accounting for system costs such as stabilising the variability of renewables (Figure 3).[7]

This trend is also reflected in the UK. Recent data from the Department for Energy Security and Net Zero (DESNZ) and Contracts for Difference (CfD) auction outcomes show that solar PV and onshore wind are now among the cheapest forms of new electricity generation in the UK. In contrast, gas-fired power generation remains exposed to volatile fuel prices and rising carbon costs, increasing long-term generation costs.[8] Figure 4 shows the estimated costs for projects commissioning in the UK in 2030. These costs are expected to decline further, especially for offshore wind and floating offshore wind, for new projects commissioning in 2035 and 2050.[9]

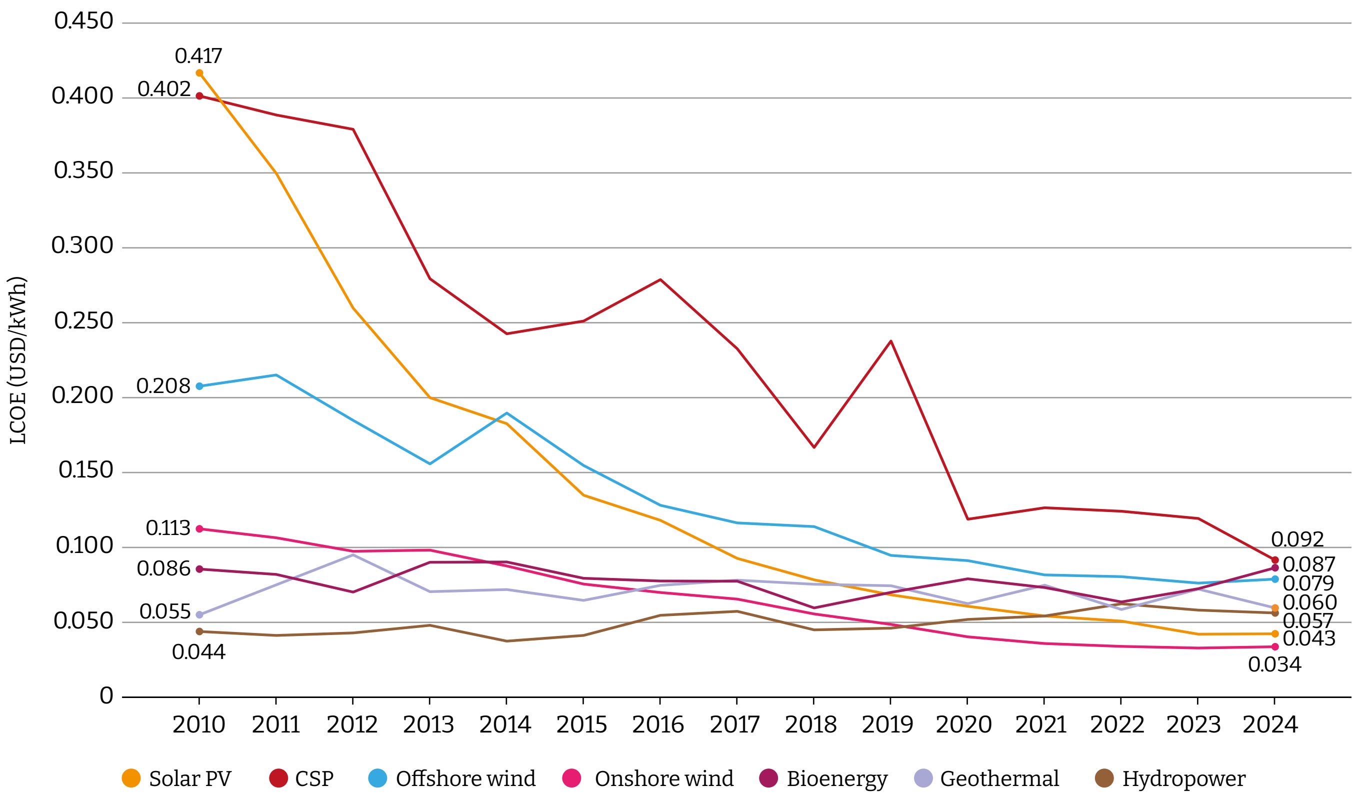
Taken together, these trends suggest that accelerating electrification alongside expanded domestic renewable generation can strengthen the UK's energy security, reduce exposure to global price shocks, and support more stable and lower long-term energy costs for households and businesses.

The UK has already made substantial progress in expanding renewable electricity generation capacity over the past two decades, particularly in offshore wind and solar, demonstrating that rapid deployment at scale is achievable. In 2024, renewables accounted for a significantly larger share (47 per cent) of UK electricity generation than gas (30.5 per cent), nuclear (14.2 per cent) or coal (0.9 per cent (Figure 5). The largest source of renewables was wind (29.2 per cent), followed by solar (5 per cent).[10]

However, the lower generation costs of renewables are not yet consistently reflected in consumer electricity bills. This is partly due to current electricity market structures, including marginal pricing mechanisms, which can link electricity prices to higher-cost gas generation during periods of peak demand.

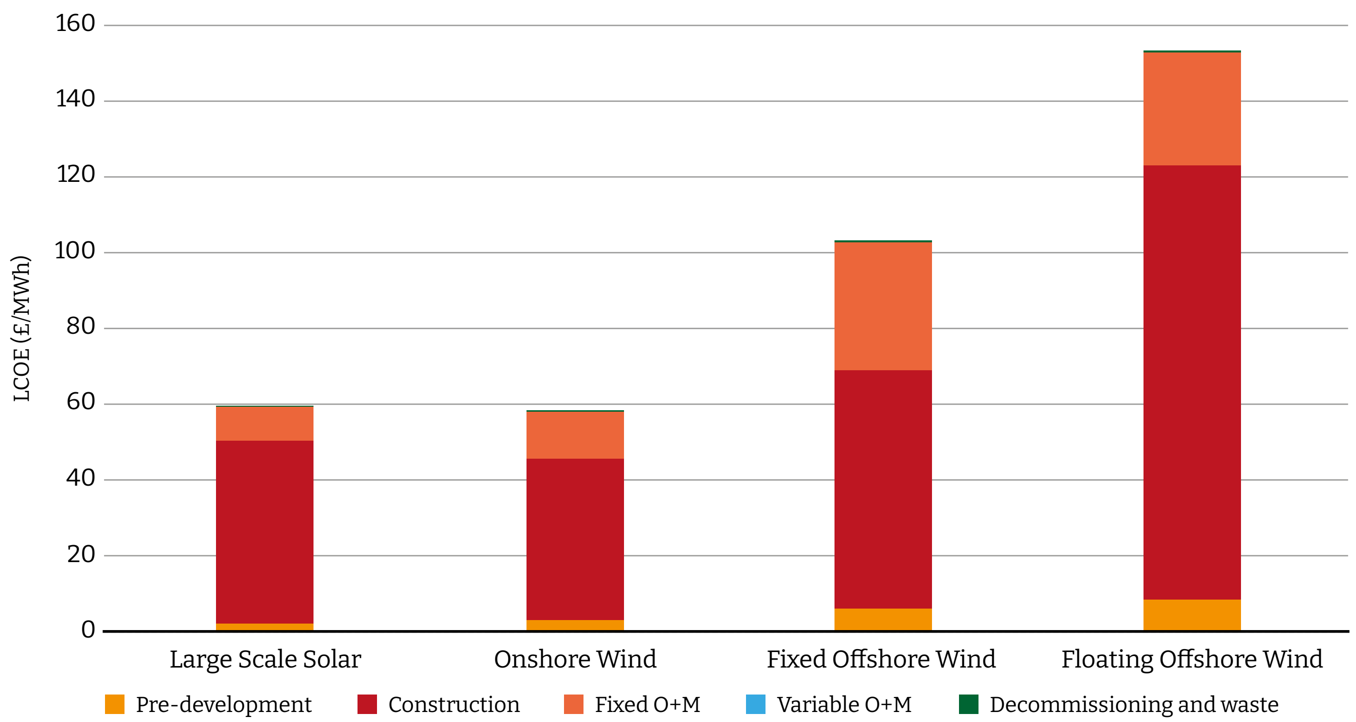
To help bring down electricity prices, some suppliers have begun introducing flexible pricing models that allow consumers to benefit more directly from periods of abundant low-cost renewable generation. The government has also proposed reforms aimed at decoupling consumer electricity prices from the cost of gas, although these measures are still under development.[11]

Figure 3: Renewables cost decline 2010–2024



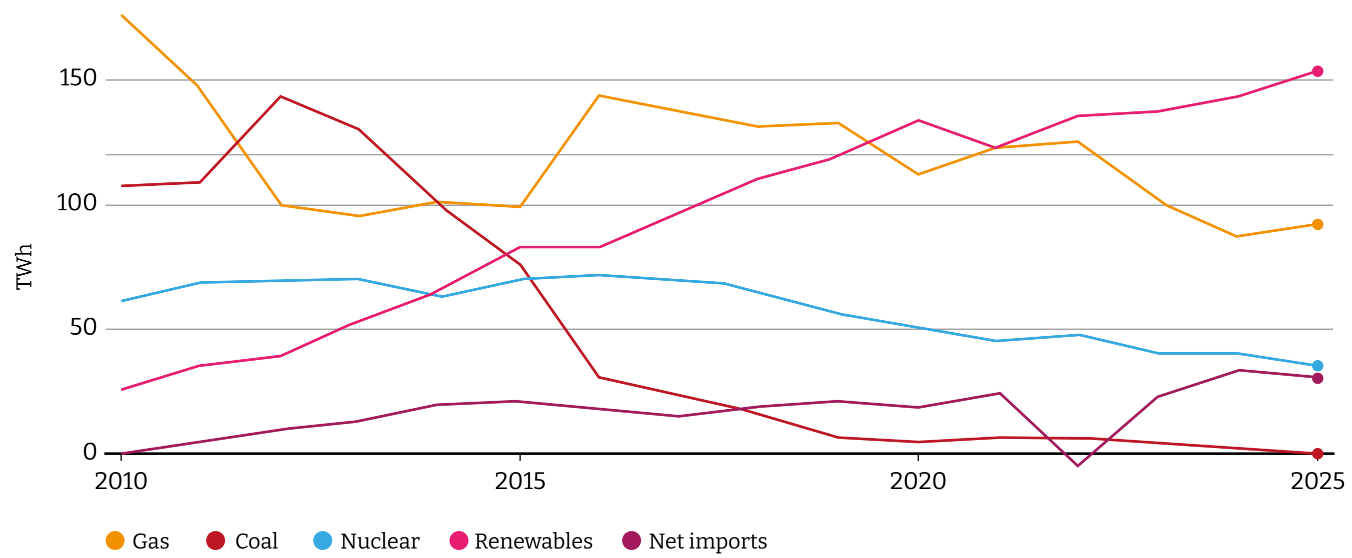
Source: IRENA, Renewable power generation costs in 2024, 2025, p. 28. Levelised Cost of Electricity (LCOE) measures the average lifetime cost of generating electricity from a given source, including construction, operation, maintenance and financing costs, divided by total electricity output. It indicates the minimum price at which electricity must be sold for a project to break even but excludes grid connection costs and subsidies.[12]

Figure 4: Key renewable technologies cost estimates in the UK



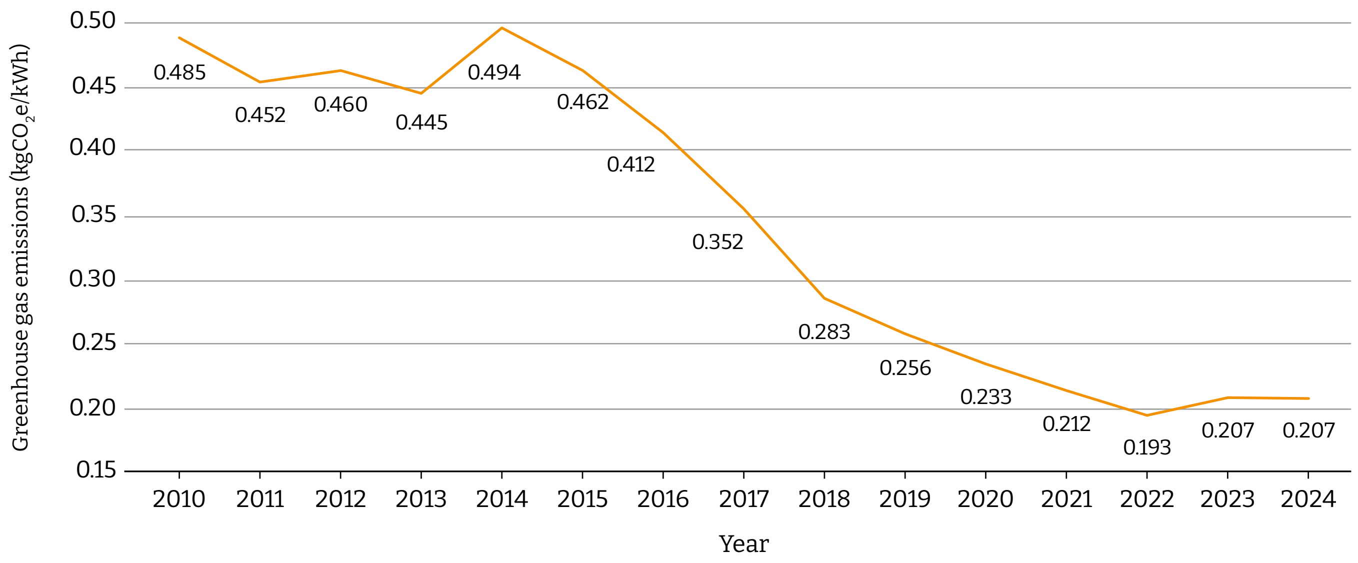
Source: DESNZ, Electricity Generation Costs 2025, 2026, p. 29

Figure 5: Energy sources used in UK electricity generation, TWh (2010–2025)



Source: Carbon Brief, Analysis: UK renewables enjoy record year in 2025 – but gas power still rises, 2026 (no page numbers)

Figure 6: UK GHG emissions from electricity generation (2010–2024)



Source: Circular Ecology, DESNZ 2024 Emissions Factors Released, 2024 (no page numbers)

2.3 Lower emissions

Natural gas creates emissions across multiple stages of its lifecycle. These include emissions from extraction and transport, methane leakage from infrastructure, and carbon dioxide released during combustion at the point of use.

Electrification using low carbon sources such as renewables and nuclear enables deep emissions reductions, mitigating climate change-related economic risks. Although renewable and nuclear power generation and transmission infrastructure is not completely fossil-free at the moment (due to embedded emissions), electricity generation from these sources produces no greenhouse gas (GHG) emissions. This is compared to over 900 g of CO_2 for each kWh of electricity generated from coal, and 382 g of CO_2 for each kWh of electricity generated from natural gas.[13]

The GHG content of electricity in the UK has declined substantially since 2010 (Figure 6) as the share of coal in electricity generation has declined and the share of renewables has increased.[14]

2.4 Implications for the UK energy system

Characteristics such as superior efficiency, domestic supply and lower GHG content mean that electrification has system-wide benefits for the UK. However, these benefits are not fully realised because of the country's heavy reliance on fossil fuels, including in sectors and uses that could be electrified.

In 2024, the final energy consumption (excluding non-energy use) in the UK was 128.1 Mtoe, up from the previous year but over 7 per cent below pre-pandemic levels.[15] Electricity accounts for less than a quarter of the UK's energy consumption and, as shown in Figure 7, its share in the country's energy mix has remained largely stagnant.[16]

Transitioning to an electrified economy is essential for achieving the strategic benefits outlined in this chapter. However, the UK is currently progressing slower than many other nations. Although the production of renewable energy has increased rapidly, the broader economy has been slow to adopt electricity as its main power source. As a result, the UK falls behind international leaders with the share of total energy consumption met by electricity standing at around 21 per cent. For comparison, electricity accounts for 47 per cent of energy use in Norway, 33 per cent in Sweden and 31 per cent in Japan.[17]

The continued reliance on fossil fuels is clear across several major UK sectors. In the transport sector, progress has accelerated since 2020, but the national vehicle fleet remains largely dependent on fossil fuels: fully electric vehicles (EVs) make up only about 5 per cent of all vehicles on the road.[18] The UK must significantly increase its adoption of electric vehicles to meet the Climate Change Committee's (CCC) target of a 90 per cent reduction in UK surface transport emissions by 2050 (relative to 2019).[19]

The challenge is also evident in the residential sector, where home heating has failed to capitalise on the superior efficiency of heat pumps, instead relying heavily on natural gas. In the winter of 2025, three-quarters of people (75 per cent) said they used a gas boiler as their main method of heating the home, while other primary methods of heating included oil boilers (5 per cent), electric boilers (4 per cent), electric radiators (3 per cent) and heat pumps (1 per cent).[20]

The UK's heat pump adoption rate is the slowest in Europe, and the overall transition away from gas heating remains slow and currently falls short of long-term government targets,[21] despite installation rates gradually increasing each year. The total number of retrofit heat pump installations recorded in 2025 was 51,886. This was a 7 per cent increase on 2024 (48,677) and over four and a half times higher than five years ago.[22]

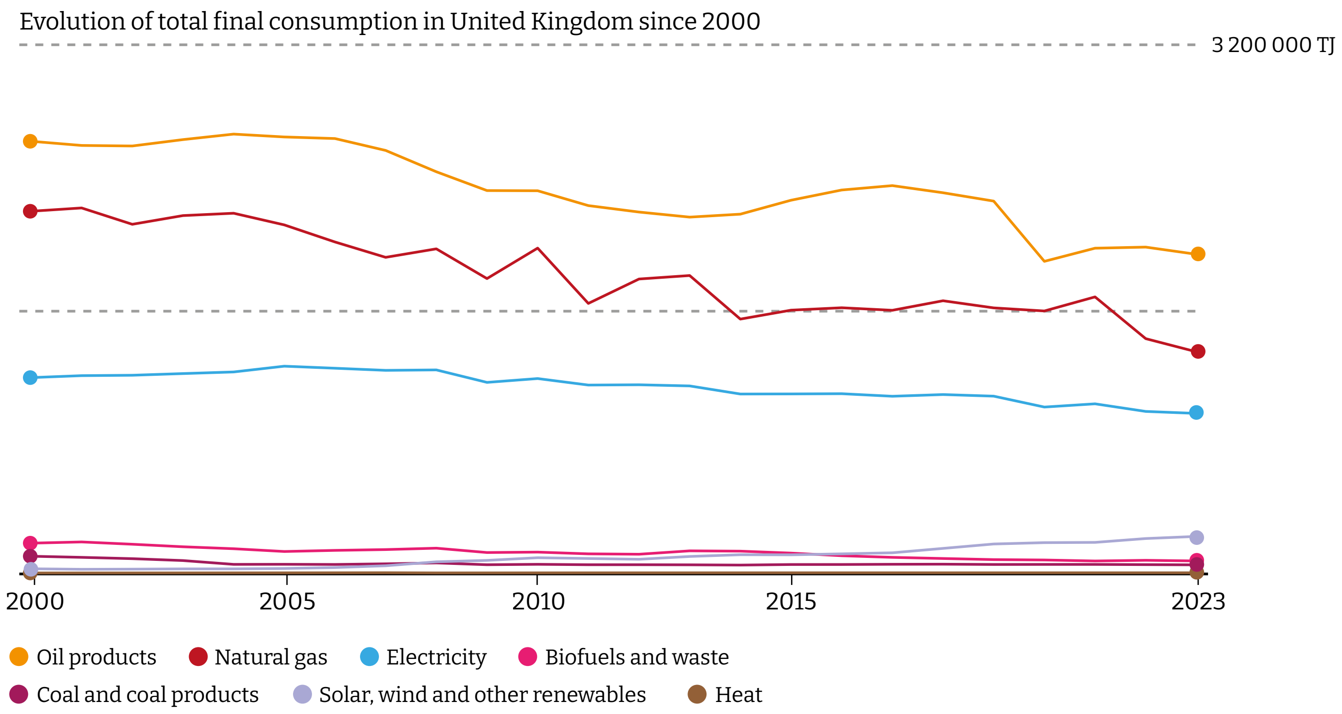
Measures under the Warm Homes Plan, the Clean Heat Market Mechanism and price pressures from global geopolitical price shocks are expected to accelerate the shift further.

Like transport and buildings, heavy industry continues to depend primarily on fossil fuels, despite a significant decline in coal consumption since 1990.[23] Natural gas and petroleum products meet approximately two-thirds of the final energy demand in UK industry, while electricity accounts for only one-third. The slow progress is linked to the substantial financial investment required to upgrade large manufacturing facilities.

Finally, the UK's public infrastructure shows a similar delay in electrification. Only about 39 per cent of the British rail network is currently electrified, compared to 60 to 75 per cent electrification rates seen in many European rail systems. While most high-traffic passenger routes use electricity, large sections of the network still rely on diesel trains.[24]

Across transport, residential heating and industry, the UK has foundational work in place but must accelerate its efforts to build a fully electrified economy. Chapters 4–9 of this report combine evidence from external sources with macroeconomic modelling to explore the potential benefits under different development pathways, and the barriers currently limiting progress.

Figure 7: Evolution of total final energy consumption in UK by source, TJ (2000–2023)



Source: IEA, United Kingdom: Energy supply, 2024 (no page numbers)

3. Modelling scenarios and methodology

The analysis in Chapters 4–9 is informed by original modelling commissioned from Cambridge Econometrics, which compares three distinct scenarios for the future development of the UK energy system against a business-as-usual (BAU) baseline. This modelling enables a forward-looking assessment of how different pathways may impact energy costs, system resilience and economic outcomes.

3.1 Short description of the E3ME model

E3ME is a well-established, global macroeconomic model that is widely used for comprehensive and tailored assessment of policy impacts.[25] It simulates a nexus between the economy, the energy system and the environment. Changes in one part of the model (eg the economy) feed back to other parts of the model (eg the environment). In contrast to most other models used to assess climate and energy policy, E3ME allows for uncertainty and the possibility of market frictions (eg gaps in knowledge and prices being slow to adjust to market conditions). Its parameters are based on historically observed relationships in the economy. This means that the estimated reactions to policies are based on historical relationships between factors such as demand, investment and costs.

3.2 The modelling approach

The scenario-based modelling assesses three different development pathways for the UK, designed to reflect the ongoing political debates around decarbonisation and technology deployment. The scenarios are described below and summarised in Figure 8. Scenario-specific additional taxes (tax income) and expenditures are redistributed through changes to income tax, social security contributions and indirect taxes (VAT), meaning that targeted tax deductions or increases do not add or cut overall costs to the government.

Each scenario is modelled under two different fossil fuel price trajectories: one where the prices follow the IEA WEO 2022 Stated Policies (STEPS) scenario[26] and a 'high fossil fuel price' alternative in which fossil fuel prices are aligned with the 'high' price trajectories from 2025 assumptions published by the Department for Energy Security and Net Zero (DESNZ).[27]

3.3 Scenarios

The baseline scenario (S0) reflects a continuation of existing policies, assuming no additional interventions beyond those already in place. It provides a reference point for assessing the impact of alternative pathways. The scenario is aligned with observed historical trends and externally validated projections. It assumes renewable deployment through existing auction mechanisms and reflects current grid investment plans, aligned with the 'Underpowered' scenario set out by Arup and consistent with the National Energy System Operator's *Falling Behind* pathway.[28] Existing policy support is maintained, including subsidies for heat pumps and electricity use in steelmaking.

In the baseline scenario, electrification progresses at a slow pace, reflecting the current situation and historic trends. The baseline scenario fails to deliver the UK's GHG emissions reductions targets for 2030, 2035 and 2050.

Scenarios 1 and 2 have been designed to deliver emissions reductions in alignment with the UK's GHG emissions reduction targets for 2030 and 2035, making it possible to mitigate residual emissions to achieve net zero by 2050. The key difference between Scenarios 1 and 2 is the way in which policy is utilised to incentivise technology deployment. However, they share certain key features, such as:

- A steadily rising carbon price, reaching around £180/tCO_2 by 2050. This provides a consistent long-term signal to shift investment away from high-emitting activities and towards cleaner options.
- Significant investment in energy efficiency, improving economy-wide energy productivity so that equivalent economic activity and energy services require around 25 per cent less energy by 2050. This lowers system costs and reduces pressure on energy infrastructure.
- Inclusion of carbon removal solutions to address residual emissions. These include land-use measures (Land Use, Land-Use Change, and Forestry – LULUCF), as well as engineered approaches such as direct air carbon capture and storage (DACCS), enhanced rock weathering and biochar.
- A regulatory phase-out of unabated fossil fuel power generation. No new coal or oil-fired power plants are built from 2026, and no new unabated gas power plants from 2031, reinforcing the long-term shift towards low carbon power.

Scenario 1 (electrification-led pathway) assumes a rapid shift to electrification as the main route to decarbonisation. Strong policy support drives widespread uptake of electric technologies, including generous subsidies for heat pumps and electricity use in industry, alongside regulations to phase out polluting heating systems. Electrification extends to transport, with most of the freight fleet becoming electric by 2050.[29] This pathway is supported by a highly ambitious expansion of the electricity grid to meet rising demand.[30] While electrification is the primary focus, complementary support is also provided for technologies such as carbon capture, hydrogen and biofuels to address remaining emissions.

Scenario 2 (mixed technologies pathway) takes a more balanced approach, with decarbonisation driven by a broader mix of technologies rather than predominantly electrification. Policy support is weighted more heavily towards hydrogen, carbon capture and storage (CCS), and biofuels – particularly in industry, power generation and transport. Electrification still plays a role, but with more moderate incentives, lower levels of grid expansion and slower uptake in sectors such as freight. Overall, this pathway reflects a more diversified but less electricity-intensive route to reducing emissions.

Scenario 3 (fossil-led pathway) reflects a shift away from net zero, with policies implemented from 2029 designed to prioritise fossil fuel production and use. This scenario explores a hypothetical policy pathway aligned with positions advanced by parties such as Reform UK, with implementation assumed from 2029 onwards following a general election.[31] In this scenario, carbon pricing (Emissions Trading Scheme – ETS) is removed, fossil fuels are actively subsidised,[32] and domestic oil and gas exploration is expanded. Investment in the electricity system remains limited, constraining electrification across the economy. As a result, uptake of electric technologies is significantly slower, and overall decarbonisation ambition falls below the baseline trajectory.

Chapters 4–6 examine how each pathway performs in terms of economic impacts, energy security and resilience, and environmental outcomes. This comparative analysis is intended to highlight key trade-offs, synergies and areas of uncertainty, providing a comprehensive basis for evaluating the relative strengths and limitations of each pathway. Evidence from external sources is used to contextualise the results.

Figure 8: Summary of the modelling scenarios

Four scenarios explore different policy and technology pathways for reducing emissions.

S0 – Baseline
Provides a baseline with existing policies and no new interventions, serving as a reference point.

S1 – Electrification-led
Emphasises increased electrification with subsidies and fossil fuel phase-outs, alongside other ways to reduce CO_2 emissions.

S2 – Mixed technologies
Includes policies to incentivise biofuels, CCS, hydrogen and efficiency measures alongside some electrification to cut emissions.

S3 – Fossil-led
Introduces enhanced fossil fuel subsidies while scrapping policies to incentivise clean technology adoption.

These scenarios are used to explore a range of possible futures and test the resilience of the energy system under different policy and technology choices.

Model assumptions (applies to all scenarios):
All scenarios are modelled in two separate fossil fuel price environments:

1. Baseline fossil fuel prices
2. High fossil fuel prices (reflecting the price increases following the 2026 US-Israel joint campaign against Iran)

4. Economic impacts

The transition to a fully electrified economy represents a structural shift from importing energy to owning the infrastructure of production. Domestically generated electricity can support new industries, jobs and investment across the UK, ensuring that a greater share of energy expenditure contributes to domestic economic growth rather than overseas fuel imports.[33]

The low carbon and renewable energy economy (LCREE) is one of the fastest growing sectors in the UK. Turnover was an estimated £77.0 billion in 2024 in current prices, an increase of £8.1 billion (11.8 per cent) since 2023. Compared with 2015, the first year of comparable data, UK LCREE turnover increased by around 91 per cent, while employment increased by over 50 per cent.[34]

Investment in UK-based infrastructure – such as solar and wind farms and nuclear power plants – generates a multiplier effect: every pound spent builds local assets, pays local wages and feeds into the UK's gross value added (GVA). This stimulates economic growth, improves the competitiveness of UK businesses and creates a more attractive environment for investment.[35]

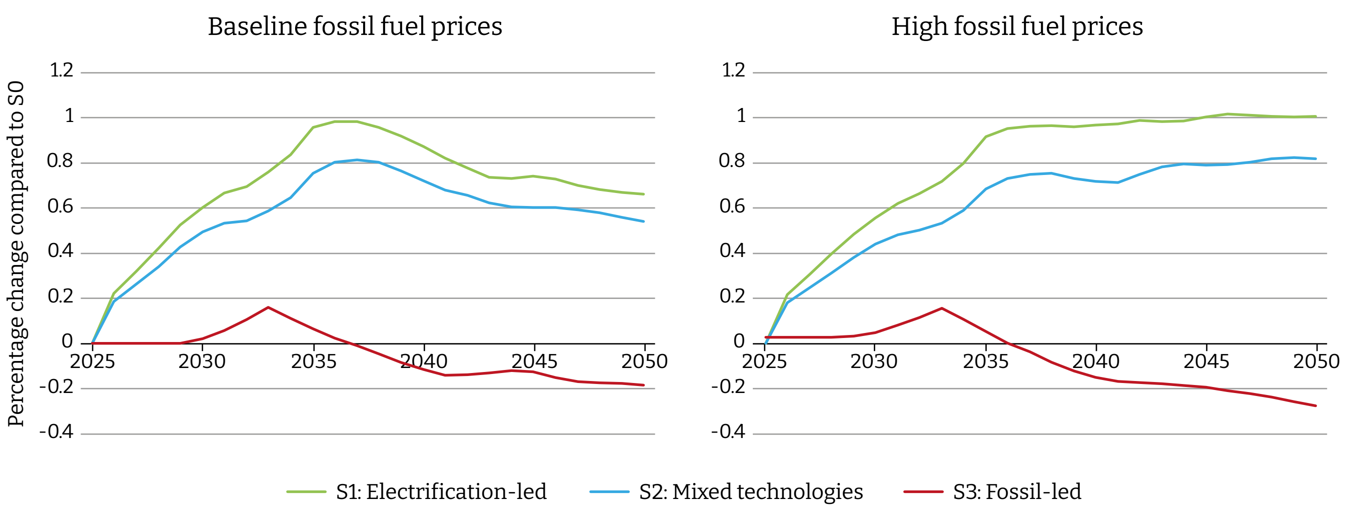
Economy-wide electrification using low carbon power also presents a significant **innovation opportunity**. The UK has the largest climate tech sector in Europe with over 5,000 start-ups and scale-ups, second only to the US.[36] While estimates of the sector's valuation vary, it was valued at between £42 billion and £56 billion as of 2025.[37] The UK can leverage this budding innovation landscape and its world-leading engineering heritage to develop and export high-value solutions in the following areas:

- **Industrial decarbonisation:** Transitioning heavy industries from high-emission processes – such as replacing coal-fired blast furnaces with electric arc furnaces (EAF) – presents a major avenue for domestic investment. Scaling industrial decarbonisation technologies is projected to deliver steady GVA growth, reaching approximately £1.8 billion annually by 2050.[38] This structural shift is expected to support up to 31,000 highly skilled direct and indirect jobs across the UK's industrial heartlands.
- **Aviation and aerospace:** Building on the UK's existing aerospace strengths to lead in sustainable aviation represents a multi-billion-pound global export market.[39] Establishing a homegrown UK sustainable aviation fuel (SAF) industry could generate £10 billion in GVA and support 60,000 new jobs by 2050.[40]
- **Transportation:** Beyond investment in passenger EVs and electrified public transport, there are other innovation opportunities such as vehicle-to-grid (V2G) technology, allowing cars to act as mobile batteries that stabilise the national grid. Data from early UK V2G trials, utilising domestic hardware manufacturers like INDRA, suggest that participating households can achieve annual energy savings of between £620 and £1,500+ by discharging stored renewable power back to the grid during peak evening demand.[41]
- **Grid infrastructure and storage:** Rising electricity demand and increasing supply-side complexity are creating a structural imperative to accelerate grid investment and modernisation worldwide. This presents a lucrative opportunity if it is properly leveraged. If the UK follows an ambitious trajectory of investments and updates, it can unlock an extra £194 billion in GVA for the UK economy to 2040 – a return on investing in the grid of 4:1.[42] This ambitious level of investment would also boost jobs, supporting an average of 92,000 additional jobs each year.

These advancements will **improve UK competitiveness** in the long term, fostering an economy that is more resilient and more attractive to foreign direct investment (FDI). The mechanisms outlined above – ie a more stable and resilient business environment, enhanced innovation opportunities, improved investment confidence and UK competitiveness – translate into measurable economic impacts. Our modelling results in Figure 9 illustrate how these effects play out across the different scenarios.

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

Figure 9: UK GDP (% difference compared to baseline)



Both **Scenario 1 (electrification-led)** and **Scenario 2 (mixed technologies)** deliver positive GDP impacts compared to the current policies baseline scenario, driven by increased investment, incomes and consumption. Among the two, Scenario 1 performs better, reflecting the lower cost of electrification as a route to decarbonisation. In both scenarios, investment in grid infrastructure and low carbon technologies is concentrated in the earlier years, leading to a peak in GDP effects around the middle of the period before stabilising over the longer term.

In **Scenario 3 (fossil-led)**, GDP initially increases from 2029 due to higher domestic fossil fuel extraction. However, this effect is short-lived. Over time, growth weakens and GDP falls below the baseline, indicating that the initial gains are not sustained and do not translate into long-term economic strength due to depletion of the North Sea reserves.

If we assume higher fossil fuel prices (on the right), reduced reliance on fossil fuels in Scenarios 1 and 2 limits exposure to global price volatility. As a result, these scenarios experience lower inflation and stronger relative economic performance, compared to baseline, when fossil fuel prices are high.

Business case study: National Grid Electricity Transmission

Energy underpins economic growth, competitiveness and opportunity across the UK. To enable this, National Grid Electricity Transmission, in partnership with its supply chain, is embarking on the largest overhaul of the electricity grid in generations. Over the last two years, National Grid Electricity Transmission has put in place commercial agreements supporting more than £20 billion of supply chain investment to enable delivery of its UK business plans, with over 80 per cent of their procurement coming from suppliers with a UK footprint.

5. Employment impacts

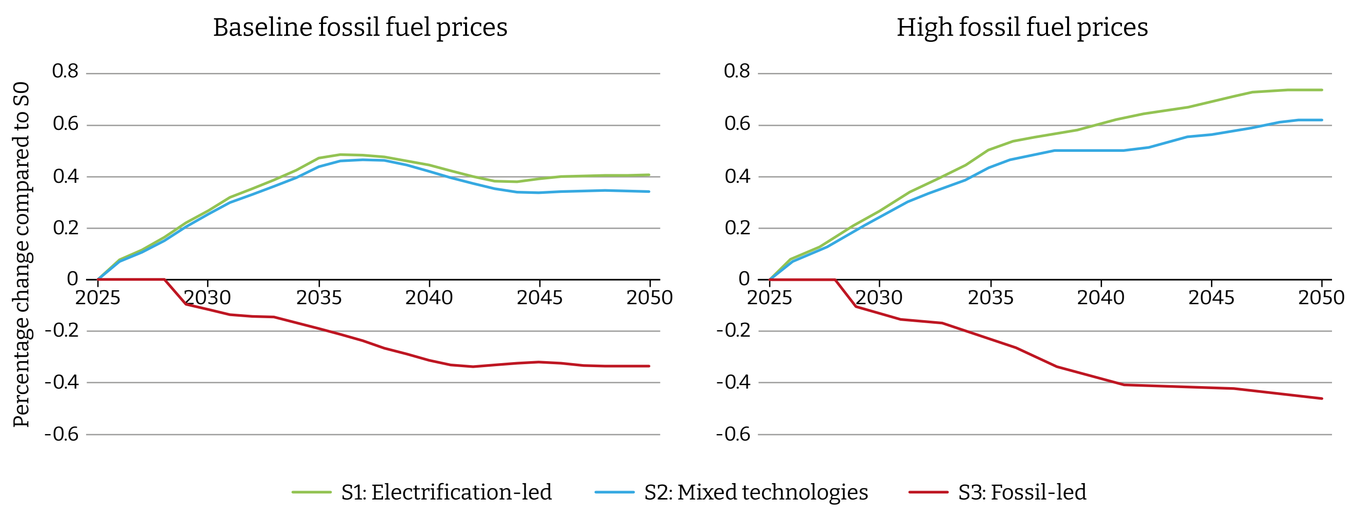
Electrification increases demand for domestic power generation, creating local jobs in a way that importing energy simply cannot. The electricity sector is already a dominant employer in the energy space: in 2025, 56 per cent of jobs in the energy sector were in electricity, while the gas sector accounted for only 22 per cent, despite gas still making up a much larger share of the UK's total fuel use.[44] This indicates that the electricity sector is far more job-intensive per unit of energy, providing a broader range of high-quality roles. Consistent with evidence from the wider net-zero economy, these jobs tend to be relatively well paid and geographically distributed, supporting economic opportunities across the UK.[45]

As shown in Figure 10, employment trends broadly mirror GDP across the scenarios, but with some important differences. In the fossil-led scenario (Scenario 3), the negative impact on jobs is more pronounced than the impact on GDP. Early gains in this scenario – which are so minor they are invisible in Figure 10 – are driven by increased oil and gas extraction, which generates relatively little employment compared to other sectors. This positive impact is also short lived because these resources are finite, meaning that employment in the sector cannot expand substantially.

By contrast, both the electrification-led scenario (Scenario 1) and the mixed technologies scenario (Scenario 2) deliver positive employment outcomes alongside GDP growth. These employment gains plateau once infrastructure expansion and enhancements slow down, but many jobs remain in renewable electricity generation and maintenance.

As a guide, a 0.1 per cent increase relative to the baseline corresponds to around 34,000 additional jobs, highlighting the scale of potential labour market benefits under these pathways.

Figure 10: Employment impacts (% difference compared to baseline)



6. Energy security and resilience

The UK's continued reliance on imported fossil fuels – particularly natural gas – creates a structural vulnerability to global price shocks driven by geopolitical uncertainty and supply constraints. Because fossil fuel prices are set on international markets, UK households and businesses remain vulnerable to shocks largely beyond domestic control. These shocks transmit quickly through the economy, affecting inflation, investment decisions and overall economic stability.

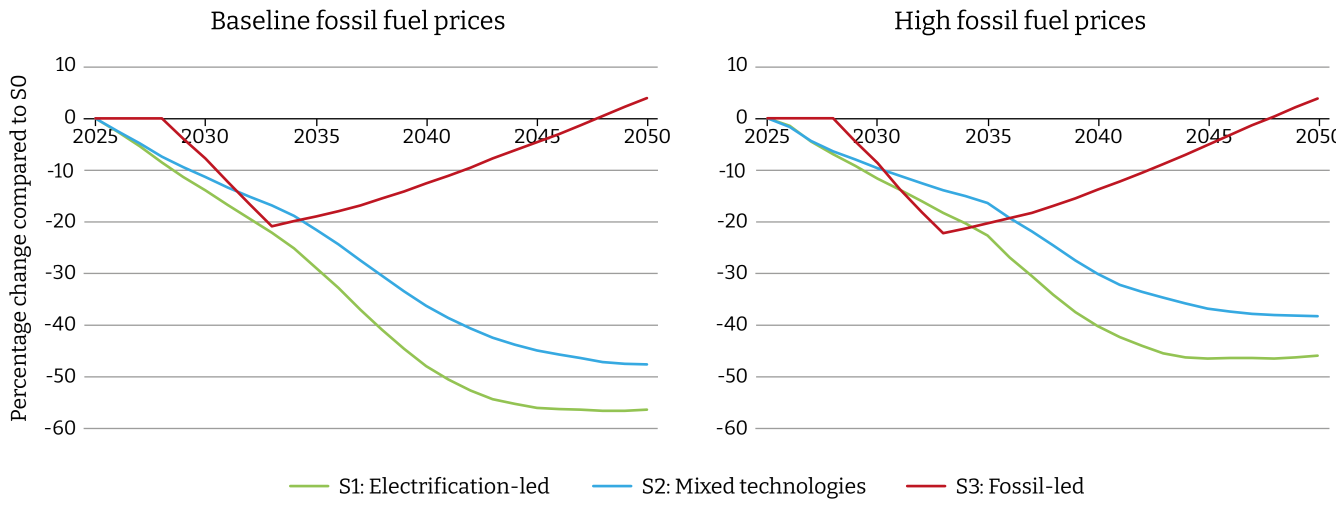
This exposure has tangible impacts at all levels. For businesses, especially small and medium-sized enterprises (SMEs) and companies in energy-intensive sectors, sudden increases in energy costs can erode margins, disrupt cash flow and reduce competitiveness. For households, price spikes increase financial pressure, reduce disposable income and dampen consumption. At the macroeconomic level, energy price volatility contributes to inflationary pressures and broader economic uncertainty, with indirect effects extending across supply chains, including food production and transport.

Reducing this vulnerability requires lowering dependence on internationally traded fuels. Electrification, combined with investment in domestic low carbon generation and storage, offers a clear pathway to achieve this. A more electrified energy system enables a greater share of energy to be produced domestically from sources such as renewables and nuclear, reducing exposure to global fuel markets and improving control over energy costs. By insulating the economy from the price shocks associated with imported fossil fuels, electrification will enhance the **UK's competitiveness** in the long term. This creates a more stable environment for manufacturing and service sectors alike, fostering an economy that is more resilient and more attractive to foreign direct investment (FDI).

While some import dependency would remain even in an electrified economy – notably for technologies and critical materials – these risks are fundamentally different from reliance on fuel imports. Once generation capacity is installed, electricity can be produced domestically at relatively stable cost, with supply driven primarily by system conditions rather than global commodity prices. Over time, these dependencies can also be reduced through innovation, recycling and diversification of supply chains.

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

Figure 11: Fossil fuel imports (monetary terms, % difference compared to baseline)



Evidence from the Climate Change Committee suggests that a transition consistent with the Balanced Pathway would significantly reduce fossil fuel import dependency, with net imports of oil and gas falling by around 77 per cent between 2025 and 2050. In contrast, continued reliance on fossil fuels would leave the UK exposed to international markets, even with increased domestic production.[46]

To quantify these risks, our modelling (Figure 11) compares how fossil fuel import costs change across scenarios relative to the current policy baseline. This provides a clear measure of the UK's exposure to global energy markets – and how far different pathways can reduce that exposure.

As shown in Figure 11, decreased fossil fuel dependence in Scenarios 1 and 2 results in a significant reduction in fossil fuel imports. This cuts the cost of fossil fuel exports (across the economy) by nearly 50 per cent compared to the baseline in the mixed technologies scenario, while the electrification-led scenario reduced the cost by nearly 60 per cent. This would substantially reduce the UK economy's vulnerability to global fossil fuel price fluctuations.

However, if the price of fossil fuels remains high (the graph on the right), the cost savings in Scenarios 1 and 2 are slightly lower because of less elastic remaining fossil fuel demand than in the baseline, where there is more scope for demand reduction and fuels switching in response to higher prices. The benefits in the electrification-led scenario exceed the mixed technologies pathways because of more limited deployment of fossil fuel-using technologies (such as power generation from natural gas using CCS).

In Scenario 3, increased fuel production initially reduces net imports of fossil fuels in monetary terms, but this trajectory is short lived. In the longer term, increased domestic extraction is unable to meet the needs of a fossil fuel-dependent economy. As a result, imports begin to rise again, eventually exceeding the baseline scenario. In this fossil-led development pathway, the UK economy will remain nearly as – or even more – vulnerable to global fossil fuel price increases and supply disruptions than is the case with the current policies (S0, baseline).

7. Environmental outcomes

Electrification can **significantly reduce GHG emissions** if generated from zero carbon and low carbon sources such as wind, solar and nuclear power. Electrification-related emissions savings can be particularly significant in energy-intensive sectors such as heavy industry and residential heating. These environmental benefits grow as the share of low carbon electricity in the UK's power supply increases.

- In the transportation sector, a medium-sized battery electric vehicle (BEV) sold in the UK in 2025 is estimated to emit a lifecycle total of just 10.7 tonnes of carbon dioxide equivalent (CO_2e) – a **72 per cent reduction** compared to the 38.5 tonnes emitted by an equivalent petrol or diesel vehicle.[47]
- In the UK steel industry, the traditional coal-based blast furnace emits approximately 2.1 kg of CO_2 equivalent for every kilogram of hot-rolled steel. Transitioning to an electric arc furnace (EAF), which primarily melts scrap metal, can slash this footprint to just 0.76 kg CO_2eq/kg when paired with direct reduction and powered by renewable electricity.[48]
- In the residential heating sector, the thermodynamic efficiency of electric heat pumps can provide profound emission savings. Replacing the gas boilers that 28.2 million UK households still rely on with heat pumps could generate annual emissions savings of around 54 million tonnes of CO_2, reducing the UK's annual CO_2 emissions by 16 per cent.[49]

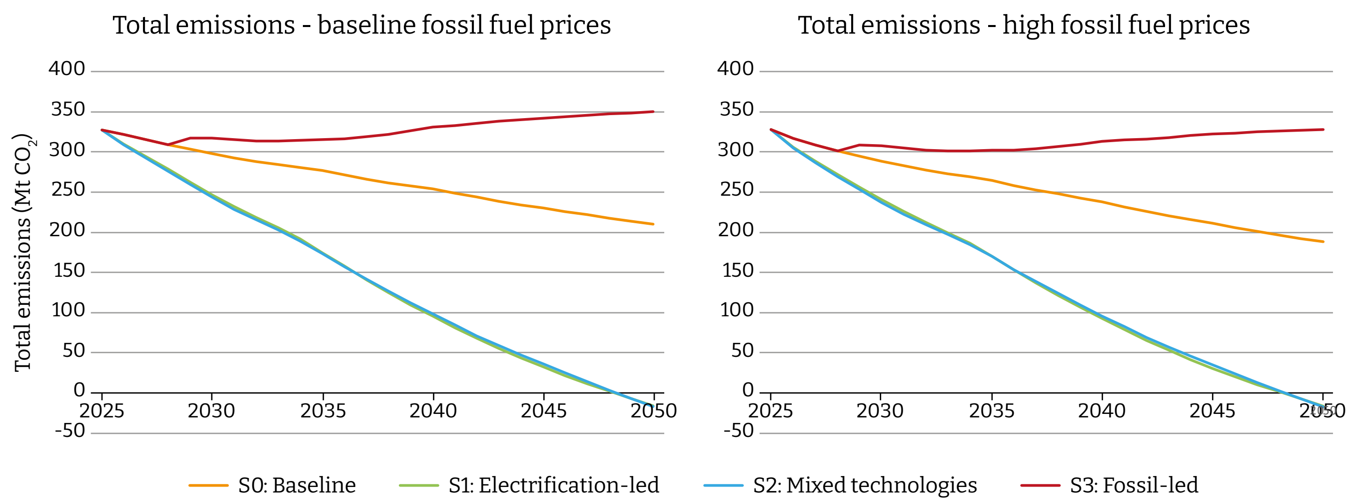
Widespread electrification at the global level – alongside decarbonisation of the power supply – can significantly reduce planet-warming GHG emissions, **mitigating global warming**. The less the planet warms, the lower are the risks associated with climate change-related biodiversity loss, extreme weather events, unpredictable rainfall patterns and their adverse economic impacts. Our modelling (Figure 12) shows that substantial GHG emissions reduction can be delivered through electrification (S1), or mixed low carbon technologies (S2), both of which deliver the UK's NDCs for 2030 and 2035. However, current policies are insufficient to meet the UK's existing climate targets, while a fossil-led trajectory would further increase the gap.

Reduced emissions and lower levels of particulate pollution associated with electrification will also **improve air quality**,[50] reducing the risk of respiratory and cardiovascular diseases, particularly in densely populated urban areas across the UK. Lower demand for fossil fuels will also reduce the **ecological damage to landscapes and seascape**s associated with drilling, fracking and mining operations.

However, the shift towards a low carbon, electrified economy is not entirely frictionless. One pressing concern within the renewable energy value chain is a lack of circularity. For example, end-of-life wind turbine blades are largely made of glass fibre reinforcements that are notoriously difficult to recycle.[51] Similarly, solar PV recycling, reuse and repair infrastructure remains underdeveloped in the UK.[52]

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

Figure 12: Economy-wide GHG emissions (Mt CO_2)



Another challenge often raised in relation to expanding renewable electricity generation capacity is the land use impact of these projects, including potential industrialisation of rural spaces. However, the extent of this is often exaggerated.[53] Purposefully designed renewable electricity generation infrastructure can even deliver ecological benefits.[54] For example, colocating ground-mounted solar panels with wildlife corridors, wildflower meadows and protected hedgerows can help restore depleted soils and support declining pollinator populations, ensuring that the land generates clean electricity while simultaneously enhancing the UK's local ecological health. An evaluation of UK solar farm planning applications highlighted that strategically developed sites, such as the Southill Energy Community Solar Farm, can achieve a biodiversity net gain (BNG) of up to 70 per cent.[55]

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

8. Energy expenditure

Electricity prices in the UK are higher than gas prices on a per-unit basis (see Section 9.1 of this report for more detail), reflecting factors such as network costs and the continued role of gas in setting wholesale electricity prices. However, for households and businesses, overall energy expenditure and exposure to price volatility matter more than unit prices.

Large-scale, economy-wide electrification and reduced fossil fuel consumption would change how energy is used as well as how energy costs are determined. As described in Section 2.1 of this report, electric technologies, such as heat pumps and electric vehicles, are significantly more efficient than fossil fuel-based alternatives, reducing overall energy demand. At the same time, shifting away from internationally traded fossil fuels lowers exposure to volatile global markets, where price shocks can quickly feed through to consumer bills and operating costs (see Section 2.2 and Chapter 6).

Our modelling results reflect these dynamics. As shown in Figure 13, electricity prices increase in real terms across all scenarios, including the baseline. This reflects the need for considerable investments into additional generation, balancing technologies and network infrastructure. The price trajectories in Scenarios 1 (green line) and 2 (dashed blue line) follow each other closely. The higher electricity prices in these scenarios reflect the costs of the additional infrastructure that is required in these scenarios.[56] In the high fossil fuel prices environment, the electricity prices in the baseline scenario and fossil-led scenario increase more rapidly than in the electrification-led and mixed technologies scenarios due to greater reliance on fossil fuels in power generation.

Although electricity prices are projected to rise, **total energy spending as a share of household expenditure declines in the electrification-led and mixed technologies scenarios** (Figure 14). This is driven by improved energy efficiency and reduced exposure to fossil fuel price volatility. In effect, higher electricity prices do not translate into higher overall energy costs, as more efficient electrified technologies enable households and businesses to reduce their energy demand.

As the left graph in Figure 14 shows, households spend more on electricity than in the baseline in both the electrification-led (Scenario 1) and mixed technologies (Scenario 2) pathways. Consumer expenditure on electricity increases above the baseline from 2030 onwards in the electrification-led scenario, reflecting the impact of fuel switching. In the mixed technologies scenario, this impact emerges from 2034.

However, the gap in electricity expenditure between Scenarios 1 and 2 and the baseline narrows over time. Crucially, as the graph on the right of Figure 14 illustrates, **higher electricity spending does not translate into higher overall energy costs in Scenarios 1 and 2**. This is because the higher electricity spending reflects the switch away from fossil fuels to more efficient electrified technologies, reducing overall energy consumption and reliance on globally priced fossil fuels.

By contrast, in the fossil-led pathway (Scenario 3), electricity spending is lower than in the baseline, but total energy expenditure is higher throughout. This reflects continued dependence on fossil fuels, which exposes households to higher and more volatile energy costs overall.

The higher fossil fuel price scenarios (Figure 15) show a similar overall pattern, although the differences in electricity expenditure relative to the baseline are smaller, while differences in total energy expenditure are more pronounced. In a higher fossil fuel price environment, consumer energy expenditure in the electrification-led scenario is around 50 per cent lower than the baseline by 2050. In the fossil-led scenario, energy expenditure is around 40 per cent higher than the baseline, reflecting greater exposure to volatile fossil fuel costs.

Figure 13: Electricity price trajectory

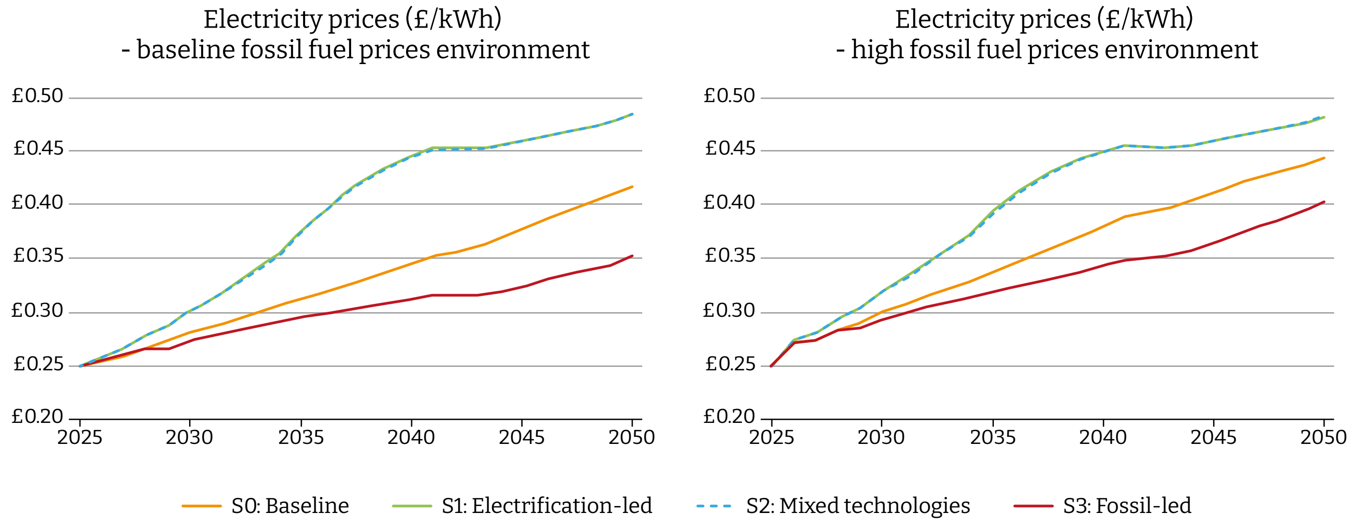


Figure 14: Consumer expenditure impacts (baseline fossil fuel prices, % difference from baseline)

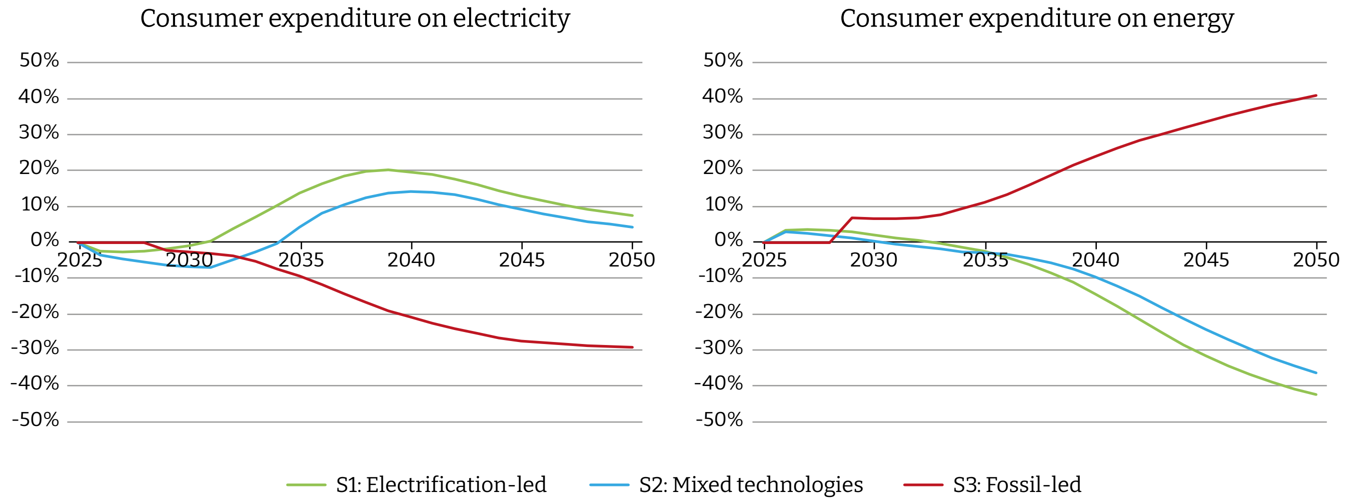
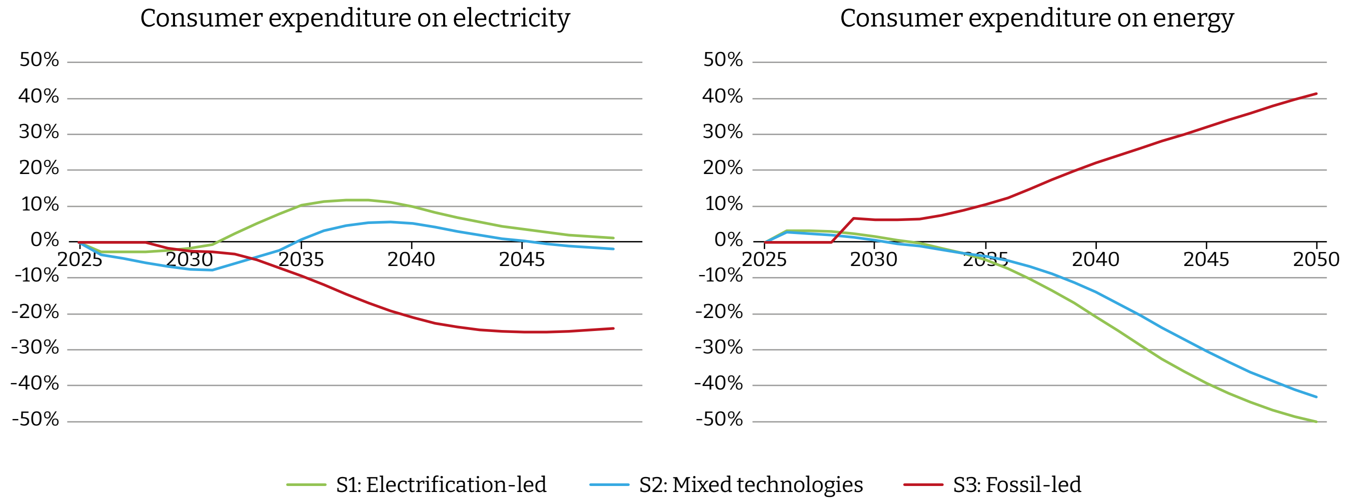


Figure 15: Consumer expenditure impacts (high fossil fuel prices, % difference from baseline)



9. Unlocking electrification: barriers and priority actions

9.1 Electricity pricing

The cost discrepancy between gas and electricity prices presents a significant disincentive to electrification in the UK. UK electricity prices are among the highest in Europe.[57] As of 1 April 2026, the average electricity price for domestic consumers in the UK[58] was 24.67 pence per kilowatt hour (kWh),[59] although the exact unit cost varies depending on contract type and payment method. Some industry and commercial consumers may have access to lower electricity prices than domestic consumers,[60] depending on their contract type, the size of the company, total usage and eligibility to assistance schemes such as the British Industrial Competitiveness Scheme (BICS) and Network Charging Compensation (NCC) Scheme.[61]

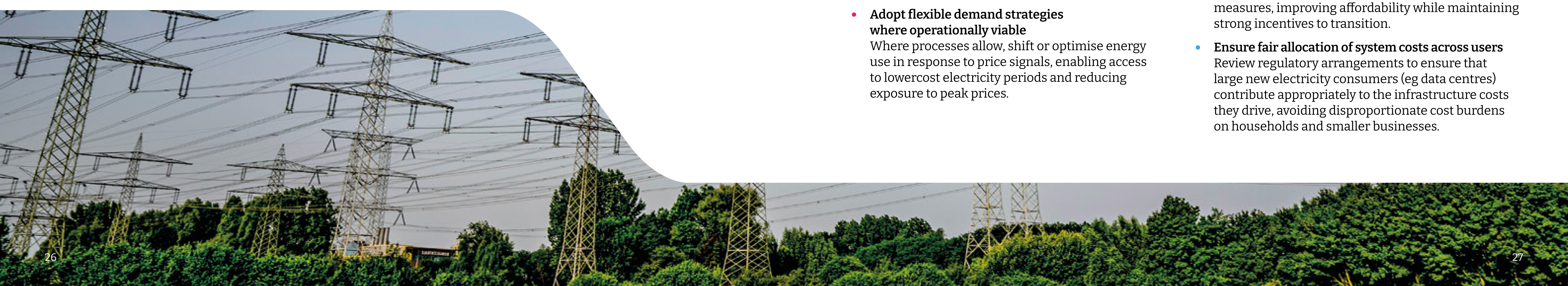
Gas prices in the UK, on the other hand, are nearly 30 per cent below the EU average, and substantially below the cost of electricity.[62] The 'spark gap' is a measure used to compare the price of a unit of electricity to that of a unit of natural gas. Between January and March 2026, the UK spark gap was 4.7:1, meaning that the cost of one unit of electricity was almost five times greater than the per unit cost of gas. Following the removal of some policy costs from electricity bills, the spark gap declined closer to 4 in April 2026.[63]

One of the reasons why electricity costs are comparatively high is that policy costs are loaded on to electricity bills to a greater extent than they are on gas bills. Some elements of the electricity market design, such as marginal pricing in the wholesale market, also mean that prices are higher than they could be.

For example, further steps could be taken to give consumers the ability to respond to price signals and encourage them to do so. This would allow consumers to benefit when there is an excess of low-cost renewable generation on the system, reducing their overall costs and providing an incentive to electrify.

Because of the high spark gap, the efficiency advantage of electrified technologies is currently insufficient to offset the significant price differential. For example, operating electric panel heaters, which is the most widely used electric heating technology in the UK at the moment, is nearly four times more expensive than operating gas boilers, despite their higher efficiency (see Chapter 2).

However, it is worth noting that higher operating costs do not apply to all uses or situations. For example, as mentioned in Chapter 2, BEVs have significantly lower operating costs than ICEs. Consumers who can take advantage of flexible pricing mechanisms and/or install some generating equipment and energy storage capacity on their premises can reduce their overall energy costs even further. Efficiency improvements to building envelopes (ie improving insulation) can also substantially reduce the energy demand while delivering similar levels of comfort in terms of space heating. The challenge is to enable more customers to benefit from lower electricity generating costs and superior efficiency of electrified technologies to the extent that makes electrification a financially viable and appealing choice for them.



Recommendations for businesses

Producers and utilities (supply side)

- **Develop and offer targeted electricity pricing products that incentivise electrification**, such as preferential tariffs for fully electric households and other customers without a gas connection, improving the value proposition of electrified technologies and discouraging new fossil fuel installations.

Consumers (demand side)

- **Invest in onsite generation and energy systems**
Deploy integrated onsite clean energy solutions, such as renewables, storage and energy management systems. These can help reduce reliance on grid electricity and manage costs more actively. In particular, energy-intensive operations such as data centres should explore these options to help meet growing electricity demand without adding pressure on the wider grid system.
- **Explore alternative supply models**
Where feasible, explore opportunities to connect to private networks or microgrids powered by renewable or low carbon electricity sources to improve cost stability, reduce exposure to wholesale market volatility and support the UK's emissions reduction goals. As above, operations such as data centres in particular should explore these options to help meet growing electricity demand without adding pressure on the wider grid system.
- **Leverage digitalisation and data for energy optimisation**
Invest in tools that improve visibility of realtime energy use, prices and system constraints. Advanced analytics can support load optimisation, demand response and more efficient use of electricity, helping to reduce overall costs.
- **Adopt flexible demand strategies where operationally viable**
Where processes allow, shift or optimise energy use in response to price signals, enabling access to lowercost electricity periods and reducing exposure to peak prices.

Recommendations for policymakers

- **Enable and incentivise tariff innovation through regulatory frameworks**, ensuring suppliers have the flexibility and incentives to offer targeted pricing structures that reward electrification, while maintaining consumer protection and market fairness.
- **Rebalance policy costs to favour electrification**
Shift policy and environmental levies away from electricity bills – where they currently fall disproportionately – and onto general taxation or fossil fuels, to strengthen the economic incentive to switch to electricity.
- **Reform electricity taxation to correct price distortions**
Reduce VAT and other taxes on electricity relative to gas, while ensuring targeted protection for vulnerable households, so that price signals better reflect decarbonisation objectives.
- **Enable more cost reflective and transparent pricing through digitalisation**
Support investment in energy system digitalisation to improve visibility of realtime supply, demand and network constraints. Enhanced use of data, forecasting and analytics can reduce inefficiencies, lower system costs, and support more transparent and predictable electricity pricing.
- **Avoid undermining price signals through untargeted market interventions**
Limit the use of market interventions that weaken incentives to electrify and risk distorting investment decisions. Where intervention is needed, support should be temporary and targeted at vulnerable consumers.
- **Recycle fossil fuel revenues to support electrification**
Use revenues from instruments such as windfall taxes on fossil fuel producers or carbon pricing to reduce electricity costs or fund electrification measures, improving affordability while maintaining strong incentives to transition.
- **Ensure fair allocation of system costs across users**
Review regulatory arrangements to ensure that large new electricity consumers (eg data centres) contribute appropriately to the infrastructure costs they drive, avoiding disproportionate cost burdens on households and smaller businesses.

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

9.2 Capital investment need

The transition to electrified technologies often requires significant upfront capital investment. Many low carbon alternatives – such as heat pumps and electric industrial equipment – remain more expensive than incumbent fossil fuel-based systems, reflecting their lower market maturity and the limited economies of scale achieved to date.[64] Even if the lifetime running costs may be lower (as is the case for BEVs v ICEs), upfront costs can act as a barrier, particularly where access to finance is constrained or investment horizons are short.

In addition to the cost of the technologies themselves, electrification may require complementary investment in enabling infrastructure. For example, deploying heat pumps may necessitate improvements to building insulation or modifications to existing heating systems to operate effectively. In industrial contexts, electrification can involve upgrades to onsite electrical systems or wider grid reinforcement to accommodate increased loads. These additional costs are often uncertain at the outset and can be sitespecific, increasing perceived risk and complicating investment decisions.

Taken together, these factors can create a 'double cost' transition challenge: a need for investment both in new technologies and in the supporting infrastructure needed to deploy them. This can delay adoption, particularly where benefits accrue over longer timeframes or where responsibility for costs and benefits is split across different actors (for example, between landlords and tenants, or across different parts of a business).

Recommendations for businesses

- **Leverage innovative financing and risksharing models**
  Pursue public–private partnerships (PPPs), blended finance and joint ventures to share the upfront costs and risks associated with electrification and infrastructure upgrades.
- **Invest in digital tools to improve investment decisions**
  Deploy advanced analytics, digital twins and asset performance tools to better assess costs, risks and returns, helping to prioritise investments and reduce uncertainty.
- **Pilot scalable electrification solutions**
  Trial electrified technologies and system upgrades in controlled settings to build internal capability, demonstrate value and reduce perceived risk ahead of wider deployment.
- **Improve access to capital across supply chains (technology producers/ providers)**
  Work with financiers and suppliers to develop financing solutions (such as leasing or service-based models) that reduce upfront cost barriers, particularly for SMEs and smaller customers.

Recommendations for policymakers

- **Derisk capital investment through targeted public finance**
  Use public investment vehicles (eg National Wealth Fund, Great British Energy) to coinvest in projects, lower risk and crowd in private capital. This is necessary particularly (but not only) for large, first-of-a-kind or infrastructure-intensive projects.
- **Expand access to affordable financing for households and SMEs**
  Develop schemes such as social leasing, low interest loans or guarantees to reduce upfront cost barriers to technologies like heat pumps, solar and electric vehicles.
- **Strengthen domestic supply chains to reduce costs over time**
  Support the development of UK-based manufacturing and supply chains for electrified technologies, helping to drive down costs through scale, improve resilience and maximise employment gains.
- **Support smart, data-driven infrastructure investment**
  Invest in digitalisation across the energy system to enable better planning and prioritisation of grid and generation investment, using advanced analytics to direct capital where it delivers the greatest system value.
- **Introduce targeted fiscal incentives to support electrification**
  Provide tax incentives or reliefs (eg for fully electrified properties or businesses) to improve the upfront economics of electrified technologies and accelerate uptake.
- **Align policy frameworks to reduce split incentives**
  Address misaligned incentives (such as landlord–tenant barriers) through regulation and support schemes, ensuring that those who invest in electrification can capture a fair share of the benefits.

9.3 Planning, investment signals and system readiness

Network investment has traditionally been reactive, responding to confirmed connection requests rather than anticipating future demand. This creates a risk of underbuilding infrastructure in areas where electrification is expected to grow. While tools such as the Strategic Spatial Energy Plan (SSEP) and Regional Energy Strategic Plans (RESPs) represent progress, they do not yet fully capture forward-looking demand – particularly from sectors such as industry, and rapidly expanding energy-intensive uses such as data centres. As a result, network companies find it hard to justify substantial investments before a demonstrated need materialises, which can slow deployment and increase the likelihood of bottlenecks.

This challenge is compounded by a disconnect between high-level policy ambition and how it translates into system planning on the ground. Government priorities – such as industrial strategy and electrification targets – are not always clearly reflected in spatial and network planning decisions. Without stronger alignment and clearer demand signals, there is a risk that infrastructure is delivered in the wrong places or at insufficient scale. Approaches such as reserving capacity for strategic demand centres could help address this, but are not yet consistently applied.

Planning and consenting processes for renewable electricity generation, storage and transmission infrastructure development cause additional constraints. Despite recent reforms to speed up infrastructure delivery (such as the 2024 Clean Power 2030 Action Plan, the 2025 Planning and Infrastructure Act and the Electricity Networks & Connections Reform), projects still face delays due to lengthy approval processes, inconsistent implementation and limited capacity within statutory bodies. Industry feedback suggests that the issue is now less about policy direction and more about the speed, predictability and resourcing of decision-making. Improving these aspects would be critical to reducing delivery risk and enabling timely investment.

Recommendations for businesses

- **Provide clear demand signals**
  Set out credible electrification plans, including expected timing, location and scale of future electricity demand, to support anticipatory network investment.
- **Engage in system planning**
  Actively participate in processes such as SSEP and RESPs, individually and through industry groups, to ensure infrastructure plans reflect real economy needs.
- **Co-ordinate and aggregate demand**
  Work with other companies to develop demand clusters and shared infrastructure solutions, strengthening the case for timely grid expansion.
- **Invest in flexibility (where possible)**
  Deploy demand-side response, storage and smart systems to align electricity use with system conditions and reduce pressure on networks.
- **Support infrastructure planning and delivery**
  Engage with affected communities early in planning processes, provide robust evidence, and collaborate with developers and authorities. This can help projects to secure the public's support, reducing delays and improving predictability.
- **Advocate policy clarity and alignment**
  Work collectively to communicate demand expectations and support stronger alignment between industrial strategy, system planning and infrastructure delivery.

Recommendations for policymakers

- **Prioritise rapid deployment of low-cost domestic generation**
  Support and prioritise the repowering of onshore wind to quickly increase low carbon generation capacity using existing sites and infrastructure.
- **Embed strategic demand within system planning and enable proactive network investment**
  Ensure future locations and capacities of strategic demand are fully integrated into SSEP and RESPs, aligned with Industrial Strategy priorities. Where capacity hubs are identified, use powers under the Planning and Infrastructure Act to reserve capacity and shift from reactive to anticipatory network build-out.
- **Accelerate and streamline planning and regulatory processes**
  Rapidly implement Planning and Infrastructure Act measures alongside targeted reforms (eg extending Permitted Development Rights for substations and revising Nationally Significant Infrastructure Project (NSIP) thresholds) to reduce delays and shorten delivery timelines.
- **Improve planning system delivery, certainty and investment confidence**
  Support reforms with adequate resourcing, clear guidance and consistent policy application. Prioritise faster, more proportionate decision-making and avoid reopening established need cases, increasing predictability and reducing project risk.

Business case study: AVEVA

Leveraging data for better grid performance, enabling electrification:
In areas where grid assets' data is effectively leveraged, grids are more efficient. For instance, UK Power Networks (UKPN), responsible for grid management in London and South-East England, uses the data it contextualises through AVEVA Pi to run its own artificial intelligence (AI) algorithms. Doing so, it is able to predict peak loads and tension periods, making the grid more efficient and enabling better planning.

Modernising the grid and leveraging AI:
The TAIGR project (Testing for AI Grid Resilience) – run by Idaho National Laboratory (INL) – is focusing on how AI can be safely and reliably integrated into electrical grid operations. Collaborations between researchers, regulators and utilities, along with the input of suppliers like AVEVA, is key to broadening the exchange of ideas and perspectives, especially with respect to AI safety in grid operations. Similar projects that rely on collaborative insights and harness the analytical prowess of AI models could deliver positive benefits for the UK as well.

Leveraging the advantages of co-location of battery storage and generation

As the transition towards a fully electrified grid accelerates, co-locating battery storage with large-scale renewable projects has become both economically and operationally essential.[65] Integrated batteries are vital for mitigating the financial risks of negative pricing while providing critical grid-balancing support during electricity shortages. However, a significant regulatory hurdle has emerged during the National Energy System Operator's (NESO) Connections Reform.[66] Under the recent Gate 2 Notification process, numerous hybrid solar-battery projects lacking prior planning consent have had their battery components forcibly removed from their proposals, even in cases where the solar capacity successfully secured a place in the new grid queue.

Forcing battery and solar assets to connect separately negates the substantial cost-sharing benefits of unified grid connections and necessitates the construction of redundant substations, potentially adding billions of pounds to consumer energy bills.[67] Furthermore, with the Strategic Spatial Energy Plan (SSEP) delayed until Autumn 2027 pushing initial grid offers to 2028, organisations such as Low Carbon feel that waiting for the SSEP to resolve this issue will be too late. Addressing this co-location barrier immediately is critical to preventing exorbitant cost increases for onshore renewables and ensuring government electrification targets remain achievable.[68]

9.4 Access to finance and insurance

Most businesses rely on debt financing for large-scale investments. However, some electric technologies, such as industrial-scale heat pumps, that are less mature or less widely deployed than incumbent alternatives are perceived by lenders as higher risk.[69] This reflects uncertainty around performance, payback periods, and the extent to which such investments will enhance profitability. As a result, lenders may apply higher risk premiums, increasing the cost of capital.[70] This, in turn, raises the upfront cost of adopting or scaling electrified technologies, particularly in capital-intensive sectors such as heavy industry and among SMEs with limited collateral. Access to finance and the high cost of capital presents a barrier particularly for industrial applications where electrified technologies are still relatively new and long-term risks (such as durability and resilience to environmental or grid pressures) are not yet well understood.

Emerging and less-established electric technologies may also face higher insurance premiums or restricted access to coverage. This is driven by perceived technology risks and a lack of historical actuarial data, further increasing the financial barriers to adoption.

Recommendations for businesses

- **Aggregate demand and scale projects**
  Bundle smaller projects (eg across sites or firms) to achieve scale, reduce transaction costs, and improve attractiveness to lenders and insurers.
- **Leverage partnerships and third-party financing**
  Work with energy service companies, infrastructure funds and technology providers to access (technology users) and offer (technology producers and energy companies) alternative financing models (eg leasing, energy-as-a-service) to reduce upfront capital requirements.
- **Generate and share performance data**
  Invest in monitoring, digitalisation and data collection to demonstrate technology performance, reliability and cost savings. This may help reduce perceived risk over time.
- **Engage early and directly with financiers and insurers**
  Collaborate with lenders and insurers during project development to address risk concerns upfront and co-develop suitable financing and coverage structures.

Recommendations for policymakers

- **De-risk investment through public finance and guarantees**
  Expand the role of public financial institutions (eg guarantees or coinvestment) to lower the cost of capital, particularly for newer technologies, extremely capital-intensive technologies (such as material manufacturing) and SMEs.
- **Support standardisation and aggregation**
  Enable standardised contracts, project templates and aggregation platforms to reduce transaction costs and improve access to finance for smaller projects.
- **Improve data availability and transparency**
  Fund and co-ordinate initiatives that generate and share performance, risk and reliability data (for example through digital twins and predictive analytics), supporting better risk assessment by lenders and insurers.
- **Facilitate insurance market development**
  Work with insurers to develop appropriate risk frameworks and products for emerging technologies, including support for pilot projects and data sharing.
- **Provide long-term policy certainty**
  Maintain clear, stable policy signals on electrification to reduce regulatory risk and improve investor confidence in long-term returns.
- **Enhance investment certainty through clear sustainable finance standards**
  Provide consistent and internationally aligned definitions of low carbon and transition activities, enabling investors to better assess risk and channel capital into electrification at scale.

9.5 Awareness, trust and skills

Limited awareness and familiarity with electrified technologies continues to shape decision-making by both households and businesses. Where people are uncertain about how technologies such as heat pumps or electric vehicles perform in practice, they tend to perceive higher risks around cost, reliability or suitability. This is particularly evident in time-pressured situations, such as emergency boiler replacements, where consumers often default to familiar systems rather than exploring alternatives.[71]

Even where information is available, it is not always clear, trusted or consistent.[72] Conflicting claims about running costs, performance or installation requirements can create confusion and discourage action. In some cases, perceptions are shaped by outdated or misleading information circulating through installers, media coverage or informal networks. This can lead to persistent misconceptions, such as overstating costs or underestimating the suitability of electrified technologies in UK conditions.

For businesses, lack of reliable information and experience translates into a practical challenge relating to staff skills and capabilities. Electrification often requires new ways of operating, from changes in equipment and processes to adjustments in procurement and energy management. This can create hesitation, particularly where internal expertise is limited or where the benefits are not well understood. In addition, skills gaps across the supply chain – from installers and engineers to system designers – can slow deployment in practice.[73] Industry feedback consistently highlights shortages of trained professionals as a constraint in scaling up electrified solutions.[74]

Recommendations for businesses

- **Provide clear, standardised information to customers (producers/suppliers)**
  Improve the transparency of costs, performance and installation requirements through simple, comparable information (eg total cost of ownership, payback periods, realworld performance). This can help reduce perceived risk and counter misinformation.
- **Invest in workforce skills and training (all)**
  Expand training for installers, engineers and sales teams to ensure consistent, highquality advice and delivery. Building inhouse expertise can support faster adoption and reduce dependence on constrained external supply.
- **Develop trusted customer journeys and advisory services (producers/suppliers)**
  Offer end-to-end support from initial assessment to installation and aftercare. This will help households and businesses navigate technology choices with confidence.
- **Improve co-ordination across supply chains (producers/suppliers)**
  Work more closely with suppliers, installers and network operators to ensure technologies are available, compatible and deliverable at scale, helping to reduce delays and uncertainty.
- **Adopt datasharing and interoperability frameworks (all)**
  Support common standards for data-sharing to improve system visibility and co-ordination across the energy system, enabling electrification demand to be met more efficiently and predictably.

Recommendations for policymakers

- **Strengthen trusted, independent advice and information channels**
  Expand access to clear, impartial guidance on electrified technologies (eg through advice services, digital tools or accredited providers), helping households and businesses make informed decisions.
- **Support workforce development and accreditation**
  Scale up training programmes, apprenticeships and re-skilling initiatives, while strengthening accreditation schemes to improve quality and trust in installation and services.
- **Create incentives for early adoption and skills development**
  Provide targeted support (eg grants, tax incentives or preferential treatment in accessing government contracts) that encourage businesses to invest in electrified technologies and associated skills.
- **Implement and expand energy data and digitalisation frameworks**
  Accelerate the implementation and expansion of energy data and digitalisation frameworks to enable more effective use of system data, improve co-ordination across market participants and support the efficient rollout of electrification.

9.6 Additional constraints affecting industrial operations

In addition to cross-cutting barriers, some constraints are specific to capital-intensive industrial users, especially if electrification is dependent on the availability and suitability of non-energy inputs. For example, steelmaking using an electric arc furnace (EAF) as opposed to a coal-consuming blast furnace (BF) relies on sufficient availability of scrap steel or alternative feedstocks such as direct reduced iron (DRI). Where these inputs are constrained, or there is a risk that they may not be available in sufficient volumes, the feasibility of electrification can be limited irrespective of energy costs.

The characteristics of electricity supply can also present challenges for certain industrial processes. Some operations require a continuous and stable energy input, which leaves them unable to enjoy the lower tariffs that incentivise flexibility and load shifting. This can create a mismatch between system design and industrial requirements, making electrified solutions less viable to operate in certain sectors.

Competitiveness considerations further shape investment decisions. Companies operating in internationally traded sectors are often exposed to tight margins and global competition, limiting their ability to absorb higher upfront or operating costs associated with electrification. This is particularly the case where customers are unwilling or unable to pay a premium for lower-carbon products, unless these offer clear advantages in price or performance. As a result, even where electrification is technically feasible, commercial constraints can slow adoption without supportive policy frameworks.[75]

Recommendations for businesses

- **Invest in process innovation and flexibility (where feasible)**
  Explore hybrid or flexible operating models (such as partial electrification, storage integration or demand management) to better align with evolving electricity system characteristics.
- **Engage collectively to shape supply chains and inputs**
  Work with industry peers to aggregate demand for critical inputs (such as scrap material feedstocks) to help improve availability and reduce cost volatility.
- **Strengthen customer engagement and green product positioning**
  Develop clearer value propositions for low carbon products manufactured using clean electricity, including performance, traceability or regulatory compliance benefits, to reduce exposure to pure cost competition.

Recommendations for policymakers

- **Create lead markets for low carbon industrial products**
  Use public procurement, standards and product carbon content requirements to create predictable demand for low carbon materials (eg green steel), enabling manufacturers to invest with greater confidence.
- **Address competitiveness risks**
  Enhance and improve targeted mechanisms – such as the UK carbon border adjustment mechanism (CBAM), ETS reform, or transition support – to mitigate the risk of carbon leakage and help firms remain internationally competitive.
- **Support the development of enabling supply chains and inputs**
  Invest in infrastructure and market frameworks that ensure the availability of critical inputs (such as scrap markets and low carbon electricity/hydrogen), recognising their role in enabling electrification pathways.
- **Provide long-term policy certainty for capital investment**
  Set out clear, stable policy frameworks (including carbon pricing trajectories, electrification strategies and industrial policy alignment) to reduce investment risk for large-scale industrial operators.
- **Strengthen system co-ordination through data and digitalisation**
  Expand energy data and digitalisation frameworks to enable system operators and network companies to better anticipate industrial demand, optimise asset use and support efficient integration of large, energy-intensive loads.
- **Support capital-intensive industrial transitions**
  Provide targeted financial support to energy-intensive industries to enable investment in electrified technologies and their operating costs, ensuring competitiveness is maintained while accelerating decarbonisation. Additional support measures may need to be targeted at industrial operations that require continuous energy supply.

10. Conclusions

This report demonstrates that electrification is not simply one pathway among many for the UK's energy transition – it is a central pillar of a more resilient, productive and competitive economy. Across all scenarios modelled, a consistent finding emerges: the scale of economic and strategic benefits increases with the degree of electrification. While alternative low carbon pathways also deliver improvements relative to current policies, the electrification-led pathway performs most strongly across economic growth, employment, energy security and long-term system efficiency.

At its core, electrification represents a structural shift in how energy is produced, consumed and valued within the economy. Moving away from globally priced and largely imported fossil fuels towards domestically generated, low carbon electricity fundamentally changes the UK's exposure to external shocks. Instead of importing energy, the UK invests in domestic assets such as generation capacity, networks and electrified end-use technologies. As a result, the UK retains value within the economy, strengthening supply chains, and creating new opportunities for innovation and industrial growth.

The modelling results underscore this transformation. Electrification-led pathways support higher GDP and stronger employment growth over time, driven by sustained investment in infrastructure and clean technologies. These investments generate multiplier effects across sectors, boosting productivity and supporting a more dynamic innovation ecosystem. By contrast, fossil fuel-based pathways deliver only short-lived gains, with performance weakening over time due to resource depletion and continued exposure to volatile international markets.

A key driver of the positive economic outcomes in the electrification-led scenario is improved energy security and resilience. The UK's reliance on imported fossil fuels leaves households and businesses exposed to price shocks beyond domestic control. Electrification – when combined with a decarbonised power system – reduces this exposure by enabling a greater share of energy demand to be met domestically. The modelling shows that electrification-led pathways significantly reduce fossil fuel imports, limiting the transmission of global price volatility into the UK economy and improving overall stability. In an increasingly uncertain geopolitical environment, this represents a clear strategic advantage.

Environmental outcomes reinforce this direction, with electrification delivering substantial emissions reductions across all sectors. However, the key implication of this analysis is that the case for electrification extends well beyond decarbonisation. The economic, resilience and security benefits are equally compelling – and often more immediate. Electrification should therefore be seen not only as a climate priority, but also as a central component of the UK's economic and industrial strategy.

Progress to date, however, remains slower than required. A set of well-understood barriers continues to constrain adoption: misaligned price signals that favour gas over electricity, high upfront capital costs and infrastructure requirements, limited access to finance, gaps in skills and trusted information, and specific constraints in industrial applications. These challenges are interconnected and reinforce one another, slowing deployment even where electrification is economically viable in the long term.

However, these barriers are not insurmountable. The analysis in this report highlights a clear set of actions that can materially accelerate progress when implemented in a co-ordinated way. Reforming energy pricing to reduce system costs can strengthen incentives to electrify. Targeted financial support and innovative financing models can reduce upfront cost barriers and unlock investment. Faster and more anticipatory infrastructure planning can ensure that networks develop in line with future demand. At the same time, improving access to information, building workforce capability and strengthening supply chains can increase confidence and support delivery at scale. For industry, tailored policy frameworks can address competitiveness concerns while enabling investment in electrified processes.

Taken together, these actions point to the importance of a co-ordinated approach across government, regulators and businesses. Electrification is not a single intervention but a system-wide transition that requires alignment between market signals, infrastructure development, investment frameworks and industrial strategy. Where this alignment is achieved, electrification can move from a marginal option to the default pathway for growth.

The evidence presented in this report is clear: the costs of delay are significant. Slower progress risks locking in higher energy costs, continued exposure to global volatility, and missed opportunities for economic growth and industrial leadership. Conversely, a faster and more co-ordinated transition can deliver substantial and sustained benefits.

Electrification is therefore not only a pathway to net zero – it is a pathway to a stronger, more resilient UK economy. With the right actions, the UK is well placed to capture these benefits and position itself competitively in an increasingly electrified global economy.

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

References

1. Department for Energy Security and Net Zero et al., "*Energy security, jobs and investment boost through climate action,*" press release, June 2, 2026,, https://www.gov.uk/government/news/energy-security-jobs-and-investment-boost-through-climate-action.

2. UK Government, *Unlocking the benefits of the clean energy economy* (UK Government, 2025), https://assets.publishing.service.gov.uk/media/6900f929ab5cc9c893799502/unlocking-benefits-of-clean-energy-economy.pdf.

3. Jasper Jolly, "Average new UK electric car price is now lower than petrol vehicles," *The Guardian*, April 17, 2026, https://www.theguardian.com/environment/2026/apr/17/new-uk-electric-car-price-petrol-ev-autotrader.

4. University of Cambridge Institute for Sustainability Leadership (CISL), *The European industry framework and lead markets: Driving innovation, competitiveness and strategic autonomy in the EU* (Cambridge Institute for Sustainability Leadership, 2026), https://www.corporateleadersgroup.com/reports-evidence-and-insights/collections/reports/european-industry-framework-and-lead-markets; Department for Transport, *Zero Emission Vehicle Mandate and CO_2 Regulations: Joint Government Response Cost Benefit Analysis* (UK Government, 2023), 67–72, https://assets.publishing.service.gov.uk/media/6554be55544aea000dfb2d59/zev-mandate-consultation-final-cost-benefit-analysis.pdf.

5. CISL, *The European industry framework and lead markets.*

6. IRENA, *Renewable power generation costs in 2024* (International Renewable Energy Agency, 2025), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Jul/IRENA_TEC_RPGC_in_2024_2025.pdf.

7. IRENA, *24/7 renewables: The economics of firm solar and wind* (International Renewable Energy Agency, 2026), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2026/May/IRENA_TEC_24-7_renewables_2026.pdf.

8. Department for Energy Security and Net Zero, *Electricity Generation Costs 2025* (UK Government, January 2026), https://assets.publishing.service.gov.uk/media/69ba657326909a14239612e3/electricity-generation-costs-report-2025.pdf. The DESNZ LCOE metric calculates the discounted lifetime cost of a generation asset, comprehensively including pre-development, capital expenditure, operating costs, fuel and financing costs. Within this framework, DESNZ defines dispatchable technologies as those that can guarantee availability and rapidly ramp output up or down to meet fluctuating demand.

9. Department for Energy Security and Net Zero, *Electricity Generation Costs 2025.*

10. Simon Evans and Ho Woo Nam, "Analysis: UK renewables enjoy record year in 2025 – but gas power still rises," Carbon Brief, January 2, 2026, https://www.carbonbrief.org/analysis-uk-renewables-enjoy-record-year-in-2025-but-gas-power-still-rises/.

11. Department for Energy Security and Net Zero et al., "Decisive action to break influence of gas on electricity prices," GOV.UK, April 21, 2026, https://www.gov.uk/government/news/decisive-action-to-break-influence-of-gas-on-electricity-prices; Rachel Millard, Ashley Armstrong and Jim Pickard, "Ed Miliband unveils move to delink UK gas and electricity prices," *Financial Times*, April 21, 2026, https://www.ft.com/content/03332af3-6fea-4e60-b0db-510172e7bb10?syn-25a6b1a6=1.

12. "Levelized Cost of Electricity," Science Direct, accessed May 25, 2026, https://www.sciencedirect.com/topics/engineering/levelized-cost-of-electricity#definition.

13. UK values. Source: "Fuel mix disclosure data table, 2024-2025," GOV.UK, updated May 14, 2026, https://www.gov.uk/government/publications/fuel-mix-disclosure-data-table/fuel-mix-disclosure-data-table#environmental-impact-relevant-to-paragraph-11-of-the-regulations.

14. "Desnz 2024 Emissions Factors Released," Circular Ecology, July 8, 2024, https://circularecology.com/news/desnz-2024-emissions-factors-released.

15. "Energy Consumption in the UK (ECUK) 2025," GOV.UK, updated April 20, 2026, https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2025/energy-consumption-in-the-uk-ecuk-2025.

16. "United Kingdom: Energy supply," IEA, 2024, https://www.iea.org/countries/united-kingdom/energy-mix.

17. "Share of electricity in total final energy consumption," Enerdata, accessed May 25, 2026, https://yearbook.enerdata.net/electricity/share-electricity-final-consumption.html?utm.

18. "The road to electric - in charts and data," RAC, accessed May 25, 2026, https://www.rac.co.uk/drive/electric-cars/choosing/road-to-electric/#how-many-electric-vehicles-are-there-in-the-uk.

19. "Progress in reducing emissions – 2025 report to Parliament," Climate Change Committee, June 25, 2025, https://www.theccc.org.uk/publication/progress-in-reducing-emissions-2025-report-to-parliament/.

20. "DESNZ Public Attitudes Tracker: Heat and energy use in the home, Winter 2025, UK," GOV.UK, March 12, 2026, https://www.gov.uk/government/statistics/desnz-public-attitudes-tracker-winter-2025/desnz-public-attitudes-tracker-heat-and-energy-use-in-the-home-winter-2025-uk#:~:text=In%20Winter%202025%2C%20three%20quarters,and%20electric%20radiators%20(3%25).

21. Ruzanna Chitchyan, "Overcoming barriers to heat pump adoption among able-to-pay households," *Energy Policy* 206 (2025): 114660, https://doi.org/10.1016/j.enpol.2025.114660.

22. "Heat pump deployment statistics: December 2025," GOV.UK, March 12, 2026, https://www.gov.uk/government/statistics/heat-pump-deployment-statistics-december-2025.

23. "UK Environmental Accounts: 2025," ONS, June 5, 2025, https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/ukenvironmentalaccounts/2025?utm; GOV.UK, "Energy Consumption in the UK (ECUK) 2025."

24. "Rail Trends 2025," GOV.UK, December 9, 2025, https://www.gov.uk/government/statistics/rail-trends-2025/rail-trends-2025?utm;
"Rail: Electrification of rail infrastructure," European Commission, European Alternative Fuels Observatory, accessed May 25, 2026, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/rail?utm.

25. A more detailed description of the E3ME model is available from: "About E3ME," E3ME, accessed May 25, 2026, www.e3me.com.

26. IEA, *Word Energy Outlook* 2022 (IEA, 2022), https://www.iea.org/reports/world-energy-outlook-2022.

27. "Fossil fuel price assumptions: 2025," GOV.UK, February 3, 2026, https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2025.

28. Arup, *Gridunlocked: Unlocking the benefits of investing in the electricity grid* (ARUP, 2026), https://www.arup.com/campaigns/gridunlocked/.

29. In alignment with the CCC's 7th Carbon budget 'balanced pathway': Climate Change Committee, *The Seventh Carbon Budget: Advice for the UK Government* (CCC, 2025), https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf.

30. Matching a highly ambitious grid investment trajectory, identical to Arup's 'Supercharged' scenario, aligned with the National Energy System Operator (NESO) Holistic Transition: Arup, *Gridunlocked*.

31. 2029 was selected as the likeliest year for the next general election because it is the latest one that can be held. It is, however, possible that a general election *could* be held before then.

32. This includes a 10 per cent rebate on hard coal, other coal, crude oil, heavy fuel oil, middle distillates, natural gas and other gas prices. The same levels of overall tax income are maintained by increasing other taxes (income tax, social security contributions and VAT).

33. Tone Langengen and Hermione Dace, "Powering the Future of Britain: How to Deliver a Decade of Electrification," Tony Blair Institute for Global Change, June 19, 2023, https://institute.global/insights/climate-and-energy/powering-the-future-of-britain-how-to-deliver-a-decade-of-electrification.

34. "Low carbon and renewable energy economy, UK: 2024," ONS, February 25, 2026, https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalestimates/2024.

35. CBI Economics, *The Race for Net Zero: The UK Net Zero Economy and the Transition to a Competitive Future* (CBI Economics, 2026), https://www.cbi.org.uk/articles/net-gains-the-uks-net-zero-economy-in-2025.

36. Alastair Hamilton et al., "Poised for take-off: Hyperscaling the United Kingdom's climate tech," McKinsey, January 15, 2025, https://www.mckinsey.com/capabilities/sustainability/our-insights/poised-for-take-off-hyperscaling-the-united-kingdoms-climate-tech; UK Government, Unlocking the benefits.

37. Freddie O'Shea, "The Next Chapter for UK Climate Innovation," Blue Earth, February 3, 2026, https://blueearthsummit.com/news/tech-nation; Charlie Mercer et al., *Climate Tech Index* (Startup Coalition, 2025), https://startupcoalition.io/u/2025/07/Climatetech-Index-2025-FOR-RELEASE-1.pdf.

38. Department for Energy Security and Net Zero (DESNZ) et al., *Energy Innovation Needs Assessment: Industrial Decarbonisation*, RAF134/2223 (UK Government, 2025), https://assets.publishing.service.gov.uk/media/694509328f4636fa2c547ed7/einas-2025-industrial-decarbonisation.pdf.

39. Nathan Harrison, "Sustainable aviation policy landscape: an overview," Aerospace Technology Institute, November 20, 2025, https://www.ati.org.uk/news-events/news/sustainable-aviation-policy-landscape-an-overview/#:~:text=The%20global%20aerospace%20market%20value,introduction%20of%20sustainable%20aircraft%20technologies.

40. Sustainable Aviation, *Net Zero Carbon Road-Map: Summary report* (Sustainable Aviation, 2023), https://www.sustainableaviation.co.uk/wp-content/uploads/2023/04/SA9572_2023CO2RoadMap_Brochure_v4.pdf.

41. "Indra releases early findings from world's largest vehicle-to-home trial," Indra, September 6, 2024, https://www.indra.co.uk/news/indra-releases-early-findings-from-worlds-largest-vehicle-to-home-trial/?srsltid=AfmBOor6LgWAoWTkAbCRyFIrckL4Jbqe-49NcMXm3BLuEkZl0-OobJbK.

42. Arup, *Gridunlocked*.

43. No reference.

44. Department for Energy Security and Net Zero, *UK Energy in Brief* (UK Government, 2025), https://assets.publishing.service.gov.uk/media/688890c3a11f859994409132/UK_Energy_in_Brief_2025.pdf.

45. CBI Economics, *The Race for Net Zero*.

46. "The Seventh Carbon Budget," Climate Change Committee, February 26, 2025, https://www.theccc.org.uk/publication/the-seventh-carbon-budget/.

47. Stephen Gifford, *The UK: A Low Carbon Location to Manufacture, Drive and Recycle Electric Vehicles*, Faraday Insights issue 12 (The Faraday Institution, November 2021), https://www.faraday.ac.uk/wp-content/uploads/2021/11/Faraday_Insights_12_FINAL.pdf.

48. Julian Suer et al., "Carbon Footprint and Energy Transformation Analysis of Steel Produced via a Direct Reduction Plant with an Integrated Electric Melting Unit," *Journal of Sustainable Metallurgy* 8, no. 4 (2022):1532–1545, https://doi.org/10.1007/s40831-022-00585-x.

49. Janet Richardson and Richard Burdett, "CO2 carbon savings of a heat pump and their environmental cost. (2026)," The Renewable Energy Hub, updated December 31, 2025, https://www.renewableenergyhub.co.uk/main/heat-pumps-information/co2-carbon-savings-of-a-heat-pump-and-their-environmental-cost#:~:text=The%20UK%20could%20save%20around,tonnes%20of%20CO2%20by%2016%25.

50. Jian Zhong et al., "Air quality and health co-benefits of bus electrification: evidence from a UK metropolitan area," *Environment International* 208 (2026): 110066, https://doi.org/10.1016/j.envint.2026.110066; James Murray, "EVs and Clean Air Zones deliver major improvements in UK air quality," BusinessGreen, July 16, 2025, https://www.businessgreen.com/news/4516433/evs-clean-air-zones-deliver-major-improvements-uk-air-quality.

51. Francesca Spini and Paolo Bettini, "End-of-Life wind turbine blades: Review on recycling strategies," *Composites Part B: Engineering* 275 (2024): 111290, https://doi.org/10.1016/j.compositesb.2024.111290.

52. Sophie L. Pain and John D. Murphy, "Forecasting solar module waste in the United Kingdom," *Energy Strategy Reviews* 61 (2025): 101849, https://doi.org/10.1016/j.esr.2025.101849; University of Cambridge Institute for Sustainability Leadership (CISL), E.ON Group Innovation GmbH and IfM Engage, *Circular Solar: The Opportunities for Increased Circularity in the Solar PV Industry* (Cambridge Institute for Sustainability Leadership, 2025), https://www.cisl.cam.ac.uk/news-and-resources/publications/circular-solar-opportunities-increased-circularity-solar-pv-industry.

53. Joshua P. Copping et al., "Ambitious onshore renewable energy deployment does not exacerbate future UK land-use challenges," *Cell Reports Sustainability* 1, no. 8 (2024): 100122, https://doi.org/10.1016/j.crsus.2024.100122.

Powering prosperity: How electrification can strengthen the UK's economy, resilience and energy security

54. OECD, *Mainstreaming Biodiversity into Renewable Power Infrastructure* (OECD Publishing, 2024), https://doi.org/10.1787/357ac474-en.

55. "Solar farms managed for nature can boost bird numbers and biodiversity," RSPB, February 13, 2025, https://www.rspb.org.uk/whats-happening/news/solar-farms-managed-for-nature-boost-bird-numbers-and-biodiversity.

56. The modelling in S1 and S2 assumes that the infrastructure expansion and enhancement are initially financed primarily by the private sector, with government involvement increasing gradually over time to 60 per cent by 2045. If a greater share of these infrastructure costs was funded from public sector sources (through taxation), especially in the early years when the investment need is greater, the cost impact would be smaller.

57. Department for Business and Trade et al., "Government cuts electricity bill for 10,000 manufacturers in boost for UK competitiveness," press release, last updated April 16, 2026, https://www.gov.uk/government/news/government-cuts-electricity-bill-for-10000-manufacturers-in-boost-for-uk-competitiveness.

58. Standard variable electricity tariff for consumers paying via direct debit in England, Scotland and Wales.

59. "Changes to energy price cap between 1 April and 30 June 2026," Ofgem, February 25, 2026, https://www.ofgem.gov.uk/news/changes-energy-price-cap-between-1-april-and-30-june-2026.

60. "Gas and electricity prices in the non-domestic sector," Department for Energy Security and Net Zero, last updated March 31, 2026, https://www.gov.uk/government/statistical-data-sets/gas-and-electricity-prices-in-the-non-domestic-sector.

61. Department for Business and Trade et al., "Government cuts electricity bill for 10,000 manufacturers.

62. Department for Business and Trade et al., "Government cuts electricity bill for 10,000 manufacturers.

63. "Energy UK Explains: The 'Spark Gap'," Energy UK, March 31, 2026, https://www.energy-uk.org.uk/publications/energy-uk-explains-the-spark-gap/.

64. CISL, *The European industry framework and lead markets.*

65. Finn Mattis Wesemeyer and Max Rettenmeier, "Co-located utility-scale battery energy storage: Modeling and economic evaluation," *Journal of Energy Storage* 164 (2026): 121803, https://doi.org/10.1016/j.est.2026.121803; Mohit Sharma, "Co-location BESS for Wind and Solar: Economic Analysis and Financing Solutions," Asset Physics, November 27, 2025, https://assetphysics.com/co-location-bess-for-wind-and-solar-economic-analysis-and-financing-solutions/; Solar Energy UK, *The economic impact of solar and battery storage* (BiGGAR Economics, 2025), https://solarenergyuk.org/wp-content/uploads/2025/04/Solar-Energy-UK-Economic-Impact-of-Solar-and-Battery-Storage.pdf.

66. Dr Iain Staffell et al., *Electric Insights Quarterly: January to March 2025* (Drax, 2025), https://reports.electricinsights.co.uk/wp-content/uploads/2025/05/WEL_Drax_EIQ_2025_Q1_Artwork.pdf.

67. Nick Molho and Sophie English, "Boosting low-carbon investment in the UK," Aviva Investors, December 11, 2025, https://www.avivainvestors.com/en-gb/views/aiq-investment-thinking/2025/12/uk-low-carbon-investment/; "Co-Located BESS and Renewables – Advantages and Risks," Blake Clough Consulting, March 26, 2025, https://www.blakeclough.com/co-located-bess-and-renewables-advantages-and-risks/.

68. UK Parliament Energy Security and Net Zero Committee, *Written evidence submitted by Low Carbon (COE0091)*, March 11, 2026, https://committees.parliament.uk/writtenevidence/163282/pdf/.

69. Kim Högnabba et al., "Economic and environmental considerations for the deployment of industrial very high temperature heat pumps in European markets," *Energy* 309 (2024): 133147, https://doi.org/10.1016/j.energy.2024.133147.

70. CISL et al., *Circular Solar*; CISL, The European industry framework and lead markets.

71. Rt Hon Chris Skidmore OBE and Nigel Topping CMG, *The Electric Economy: Creating Consensus, Communicating Change* (Climate Action Coalition, 2026), https://coalition.climateaction.org/wp-content/uploads/2026/01/CAC_UK_Clean_Power_Taskforce_Report-1.pdf.

72. Hector Pollitt and Migle Petrauskaite, "A policy framework for clean energy technology adoption," *npj Clean Energy* 2, no. 9 (2026), https://doi.org/10.1038/s44406-026-00022-y.

73. "Electrical skills gap deepens as apprenticeship starts fall despite surging demand," ECA, February 9, 2026, https://www.eca.co.uk/news/2026/feb/electrical-skills-gap-deepens-as-apprenticeship-starts-fall-despite-surging-demand.

74. For example, see: Sarah George, "Skills shortage threatens Britain's heat pump rollout as installer numbers decline," edie, August 20, 2025, https://www.edie.net/skills-shortage-threatens-britains-heat-pump-rollout-as-installer-numbers-decline/.

75. CISL, *The European industry framework and lead markets*.

UNIVERSITY OF CAMBRIDGE | Institute for Sustainability Leadership

Cambridge insight, policy influence, business impact

The University of Cambridge Institute for Sustainability Leadership (CISL) brings together business, government and academia to find solutions to critical sustainability challenges.

Capitalising on the world-class, multidisciplinary strengths of the University of Cambridge, we deepen leaders' insight and understanding through our executive programmes; build deep, strategic engagement with leadership companies; and create opportunities for collaborative enquiry and action through our leadership groups.

Over more than 30 years we have built up a leadership network of nearly 40,000 leaders and practitioners from business, government and civil society, who have an impact in every sector and on every continent. Their experience and insights shape our work, which is further underpinned by multidisciplinary academic research. His Majesty King Charles III is CISL's Royal Founding Patron and has inspired and supported many of the Institute's initiatives, during his time as the Prince of Wales.

Head office
The Entopia Building
1 Regent Street
Cambridge CB2 1GG,
UK

T: +44 (0)1223 768850
info@cisl.cam.ac.uk

EU office
Norrsken House
Rue du Commerce 72
B-1040 Brussels
Belgium

T: +32 (0) 2887 92 40
info.eu@cisl.cam.ac.uk

Cape Town
Workshop17 NCG 146
Campground Road
Newlands 7780
Cape Town, South Africa

T: +27 (0)21 300 5013
info.sa@cisl.cam.ac.uk

www.cisl.cam.ac.uk **@cisl_cambridge**